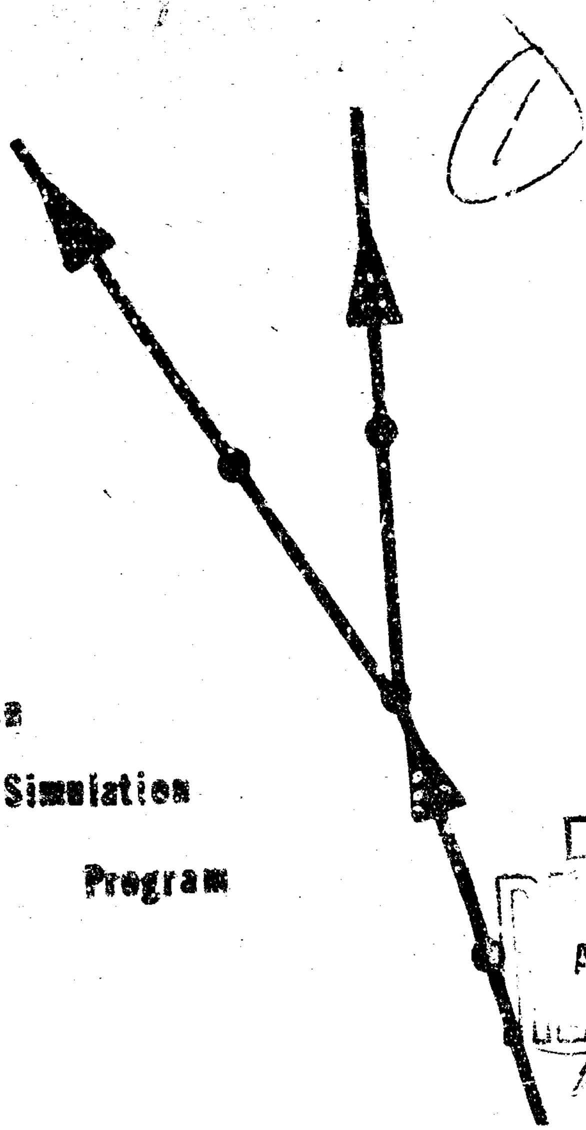
River Basin Simulation Program



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RIVER BASIN SIMULATION PROGRAM

by

William C. Pisano*

*Sanitary Engineer, Division of Technical Control, Federal Water Pollution Control Administration, U.S. Department of the Interior

ACKNOWLEDGMENTS

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PREFACE

The set of programs and options described in the activity ~~this document~~ provide a versatile new approach to river basin planning for water quality management. Although water quality relationships are the primary considerations of the calculations performed here, the programs are very general and can be manipulated to consider many water uses. Since water quality strongly affects all uses of water, the programs are designed to consider most of the legitimate water uses. The models are capable of analyzing the quality-quantity interrelationships for municipal and industrial water supply, flood control, fish and aquatic life, irrigation, and recreation. These and other uses can be considered either by studying how to manage existing situations or by introducing various design alternatives concerning physical and structural components. As an analytical technique for planning and utilizing river basins, this "River Basin Simulation Program" represents a major programming effort having as its base a sound analytical and engineering consideration of water quality.

The programs offer a logical framework for a sound technical analysis of those aspects of a water resource system that influence water quality. As in the case with most useful and sophisticated management tools, the people who commit themselves to using this program will (1) find that their efforts suggest useful alternatives for Government action and (2) they will receive useful insights into the complexities of river basin systems. Upon examining these and other indices and distributions, the engineer or planner can identify which alternative proposal is superior.

The program models the behavior of a river basin with the primary intention of using Monte Carlo Sampling (simulation) to find the occurrence frequencies of: (1) various water quality indicators or pollutant fluxes, (2) water supply deficiencies, (3) seasonal flows, and (4) reservoir contents. The computations performed are designed for the users within the Federal Water Pollution Control Administration; however, the underlying logic is sufficiently general to make the program useful to other organizations interested in water resources. For example, irrigation, flooding, and navigation can be studied.

The user prepares a set of input cards for the program which serve two functions. The first function describes: (1) a natural hydrologic regime, (2) evaporation and seepage conditions, and (3) ambient water quality. The second function specifies the plan which can be comprised of: (1) water quality objectives (standards), (2) flow requirements and diversions, (3) waste loadings from towns, industries, and irrigations districts, (4) various dams, and (5) (optionally) a table of the release schedules to be used at the dams.

The program finds the probable hydrologic and water quality consequences of the imposition of such a plan on the unregulated or natural hydrologic regime of the basin. The program permits the user to investigate many plans for the same basin.

Note that the effects of various design decisions (or plans) are measured in physical terms and that there is no facility in the program to consider the various costs and benefits involved. The economic consequences of design choices must be considered externally to the program.

Users of the program can verify existing conditions and simulate various management alternatives. The list of alternatives that can be examined includes studying various combinations of reservoir sizes, reservoir releases and waste input schedules. An attractive, major feature is the ability to study transfer of water from another basin. The study of existing conditions is a means of evaluating the adequacy and practicality of water quality standards.

Answers are obtained in the form of statistical information concerning the probable consequences of the implementation of proposals under study. Consequences evaluated are water quality, streamflow, and reservoir levels at preselected locations. The program yields information including statistical moments and probability distributions of the following quantities:

1) Pollutant concentrations at various prespecified locations;
2) Reservoir levels;
3) Flows and truncated flows above and below prespecified requirements.

For a typical system, there is a large amount of information provided as output from the program. Output is labeled clearly and without ambiguity for the convenience of the users. This wealth of information provides the facts upon which rational decisions can be based.

These programs are intended to be an aid for establishing uniformity among FWPCA Project and Regional offices and other agencies, and to make statistically efficient use of hydrologic or water quality records that exist.

INTRODUCTION

The program offered here is founded on well-known statistical theory, which is thoroughly documented and cited in the statistical and engineering literature. It is presumed that at least one member of any team who uses this program is familiar with the notation, terminology, and underlying mathematical structure of the theory. While intimate knowledge of the algebraic manipulations is helpful, it is surely not required.

To attain the necessary statistical background, special attention is directed to the following sources:

1. Maass, Arthur A., et al., The Design of Water Resource Systems, (Harvard University Press, Cambridge, 1962), cf. chaps. 12-14.

2. Operations Research in Water Quality Management, Report of the Harvard Water Resources Group to the United States Public Health Service, 1963; cf. chaps. 1 and 2.

3. Fiering, Myron B, "Queuing Theory and Simulation in Reservoir Design," Trans ASCE, Hydraulics Division, 127, 1962.

4. Fiering, Myron B., "A Multivariate Technique of Synthetic Hydrology," ASCE, Jour. Hyd. Div., 90, September 1964.

5. Kendall, Maurice G., A Course in Multivariate Analysis, (Hafner, New York, 1957).

6. Fair, G. M. and Geyer, J. C., Water Supply and Waste Water Disposal, (John Wiley & Sons, Inc., N.Y., 1954), cf. chaps. 4-6.

7. Hoel, P. G., Introduction to Mathematical Statistics, Ed. 3, (John Wiley & Sons, Inc., 1962).

8. Fruend, J. E., Mathematical Statistics, (Prentice-Hall, Inc., N. J., 1962).

9. Hufschmidt, M. M. and Fiering, M. B, Simulation Techniques for Design of Water-Resource Systems, (Harvard University Press, Cambridge, 1966).

10. Young, G. K. and Pisano, W. C., "Operational Hydrology Using Residuals," ASCE, Jour. Hyd. Div., -, July 1968.

Informational requirements of the program include data on (1) historical flows (2) geometric location of reservoirs, waste inputs, and water users (3) background water quality relationships (4) evaporation (5) magnitudes of water use, waste input, and reservoir volumes, and (6) waste scheduling and reservoir management practices.

Individual questions can be broad as, how do present management practices in the basin influence water quality at a state boundary or how does a change in practices affect the quality at a critical point? A more specific question would be: Will the flows in a wild portion of the river basin be sufficient to maintain a required wetted perimeter for fish spawning? Both types of questions are important and both can be analyzed.

Essentially, there are two elements in the program. Multisite streamflow simulation is designed to capture the hydrologic nature of real river systems. This step is designed to cause the important random characteristics of the historical records to be duplicated in synthesized records. Historical and simulated streamflows are routed through the river system. Quality is introduced as an operational quantity through streamflow-water quality relationships as well as by defining the existing waste discharge practices. Both elements require the full computing power of the largest computers.

How big can the river system be? The river system can have 15 reaches where water quality is critical, 10 confluence points, 10 waste input points, and 15 reservoirs. The program can handle five water quality pollutants, one of which may be degradable, and also can consider dilution flows for water quality requirements. Releases and withdrawals for any purpose may be included to study their effects on water quality. The unique feature of the program is that pollutants as well as flows are routed through the system. The release schedules for dams may follow current practice or may be altered in an attempt to manage the system for changing goals and needs.

Each proposed design or plan is statistically evaluated in terms of the water quality and streamflow characteristics at strategic river basin locations. A histogram, or frequency function of deficiencies from which the mean, variance, and skewness of the population of deficiencies can be estimated, contains necessary design information about the set of deficiencies which might be obtained if the system were built or operated as planned.

For a given river basin having towns, industries, recreational areas, irrigation districts, fish spawning reaches, existing reservoirs, and perhaps other complex elements, many questions can be answered through use of the program. The program relates the various activities in the basin to the underlying hydrologic conditions which must be satisfied.

IMPLEMENTATION

To use this program, the following materials are needed. An IBM 360/65 data processing system and three classes of punched cards describing options, controls, data, and design; these cards comprise the input. The machinery is a formidable collection of hardware, but it is necessary to process the data collected from a large number of sites in a river basin. The capacity of the core storage is nearly exhausted by the program. The programs are written in FORTRAN IV language.

The three classes of punched cards comprising the input consist of the following specifications:

1) the control cards which specify lengths, basin size, etc.,
2) data cards giving the (fixed) hydrometeorologic variate values,
3) design cards specify the set of (variable) design choices to be investigated during each run.

There are three major options in this package. One option (NMP) (Numerical Multisite Program) concerns the generation of operational hydrology. Another, "B" (Basin) is devoted to the detailed flow routing necessary to model a suitably defined river basin. A third lesser option (D), arbitrarily called "DEM" combines these two concepts in a one-dimensional inflow model; this option is considered first.

1. Option D considers a deterministic or stochastic target flow to be met by releases from a single storage facility on a single stream. Input consists of a few control cards, followed by data cards which contain the hydrologic record, the vectors of flow requirements, and other miscellaneous inputs to the model.* These are followed by design cards containing those storages which are to be evaluated by the program. A sample single stream system is displayed in Figure A.

The program deals in basic time units or seasons of 1,2,3,4,6 or 12 months. Each seasonal flow requirement reflects a discharge sufficient to assure that municipal and industrial water supply requirements are met or that the maximum allowable concentration of any pollutant is not exceeded at a point immediately below the dam unless all the water in upstream storage is depleted.

For each set of seasonal flow requirements, or dilution vector, the program loops through all storage capacities provided in the input. As many as ten different capacities may be examined.

*These miscellaneous items will be dealt with later in the section on card input requirements.

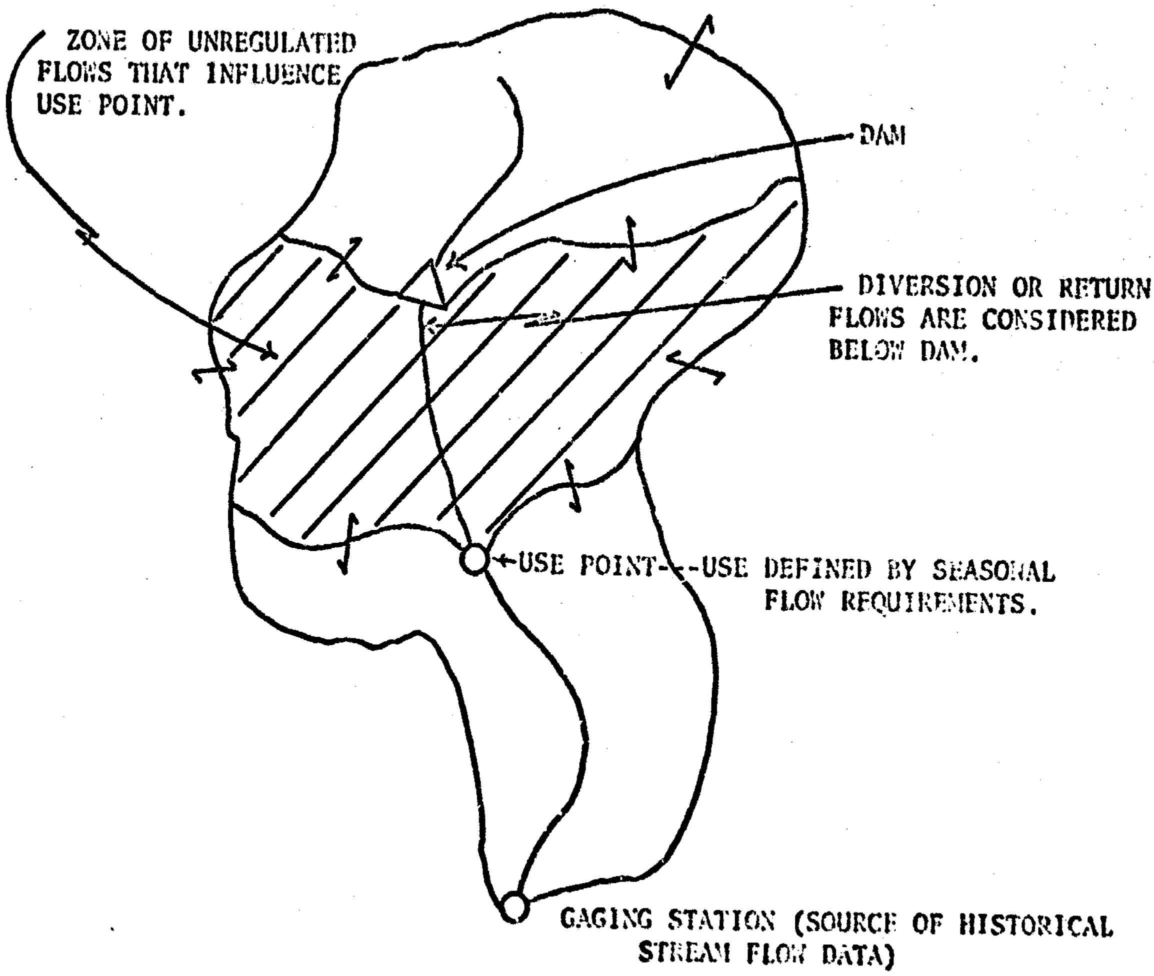


FIGURE A - MODEL D

The program allows for three different modes of reservoir operating policies. The first of these modes always attempts to maintain the downstream flow requirement in every season. The second uses a set of rule curves to determine the outflow from the reservoir for each season. This mode requires as input, coefficients for a set of seasonal regression equations relating release to storage and inflow. In addition, rules prescribing maintenance of a percentage of reservoir capacity may be specified.

Stated in any way, a rule can be inputted to keep a reservoir at certain pool elevation during any part of the year. Thirdly, the program uses the second mode with the constraint of maintaining down stream flow requirements.

For each combination of dilution vector and storage capacity, the program routes the hydrologic record through the reservoir using the prespecified operating policy and then tabulates and prints statistical characteristics of performance. Finally, the program generates univariate operational hydrology (in accordance with the Thomas-Fiering algorithm which recursively produces synthetic flows in accordance with the Gaussian lag-one Markov process). The operational hydrology is presumed to derive from flows having a frequency function that is i) normal, ii) square-root normal, iii) log normal. The program specifies the appropriate choice from the input data. (10).

In addition to synthetically generated (operational) hydrologic inputs, the program can generate a random component for each season's flow or dilution requirement. The requirement in any season is presumed to vary normally about its average value and the input includes the season mean α_j and the seasonal standard deviation Δ_j. From these and a normally distributed standardized sample deviate, a random number u (0,1) N the program calculates R_j, the target flow for season j from

$$R_j = \alpha_j + u \cdot \Delta_j \geq 0.$$

To run the model using a set of deterministic values for the dilution vectors, it is necessary only to set $\Delta_j = 0$

If desired, seasonal diversions may be considered at the reservoir site before any releases for downstream users are made. This allows for evaporation losses, seepage, or direct pumpage out of the reservoir into another basin. Any addition to the system below the reservoir; e.g., irrigation return flows, may be accommodated. This is accomplished by prefixing the seasonal diversion with a minus sign. As in the case of the downstream flow requirements, a random component may be added to the seasonal mean diversion.

The routing and tabulation of system performance under synthetically generated variables (operational hydrology) is effected identically to the historical record. When all dilution vectors are exhausted, the program searches the input tape for a new site to investigate. Should none be available, the job terminates.

This option pertains to a single stream; the multi-stream case is studied by the dual usage of Options NMP and B as discussed below.

2. Option NMP deals with multivariate distributions of hydrometeorological data, with their correlation structure, and with the generation of long traces of operational hydrologic records using parameters extracted from the observed record. The basic time unit of the generating algorithm is subject to input control, but is limited to intervals of 1,2,3,4,6 or 12 months. See (10) for operational details.

The input deck for NMP consists of several control cards and a large number of data cards giving the variate values.

3. Option B is a generalization of the flow routing performed in Option D. Instead of investigating the performance of a system consisting of a single structure and a single use point, this option can consider any geometrical configuration of up to 15 potential reservoir sites, 10 effluent discharge sites, 25 use or test sites, and 5 pollutants. Streamflows, effluent loads and releases from reservoirs are perfectly and instantaneously mixed and are routed downstream from point to point in the system.

The entire routing of the basin, from the headwaters to the mouth, is accomplished during each time frame. The month is the length of the time frame considered by this program. Thus only those river basins whose streamflows have an average travel time of a month or less can be treated.

This option performs (logically) much like the simpler Option D. A notable exception is that the synthetic variables (streamflows) are not generated by Option B because of the time and storage limitations; particularly the latter. To examine behavior using historical flows as inputs, the program expects the observations to be on cards or magnetic tape; for long operational traces the program will generally be run following Option NMP.

A. Specification of the Geometry of the System

This option operates on any configuration of 50 or fewer points. By definition each point or coordinate is a location of utilitarian or geometric interest and five types of points are considered in the program:

1. Test point or use point; a water supply demand or diversion is treated as a test point.

2. Waste discharge point.

3. Damsite.

4. Junction point; the confluence of two (and only two) streams. The program considers all junction points to be test points.

5. End point.

A schematic diagram of the basin and the interconnections among its components is essential for preparation of the card input. The following set of rules, and the related example, demonstrate the order and format of the input deck. The sample basin is displayed in Figure B. River miles to all points are shown in a coordinate system approximately equivalent to that of the STORET System, but it will be seen that the exact mileages and geographic coordinates are far less important than the relative position of each point with respect to its neighbors. Development in the basin is indicated by the presence of dams, municipalities, and industries; the drainage area corresponding to each reach of the several streams is cross-hatched.

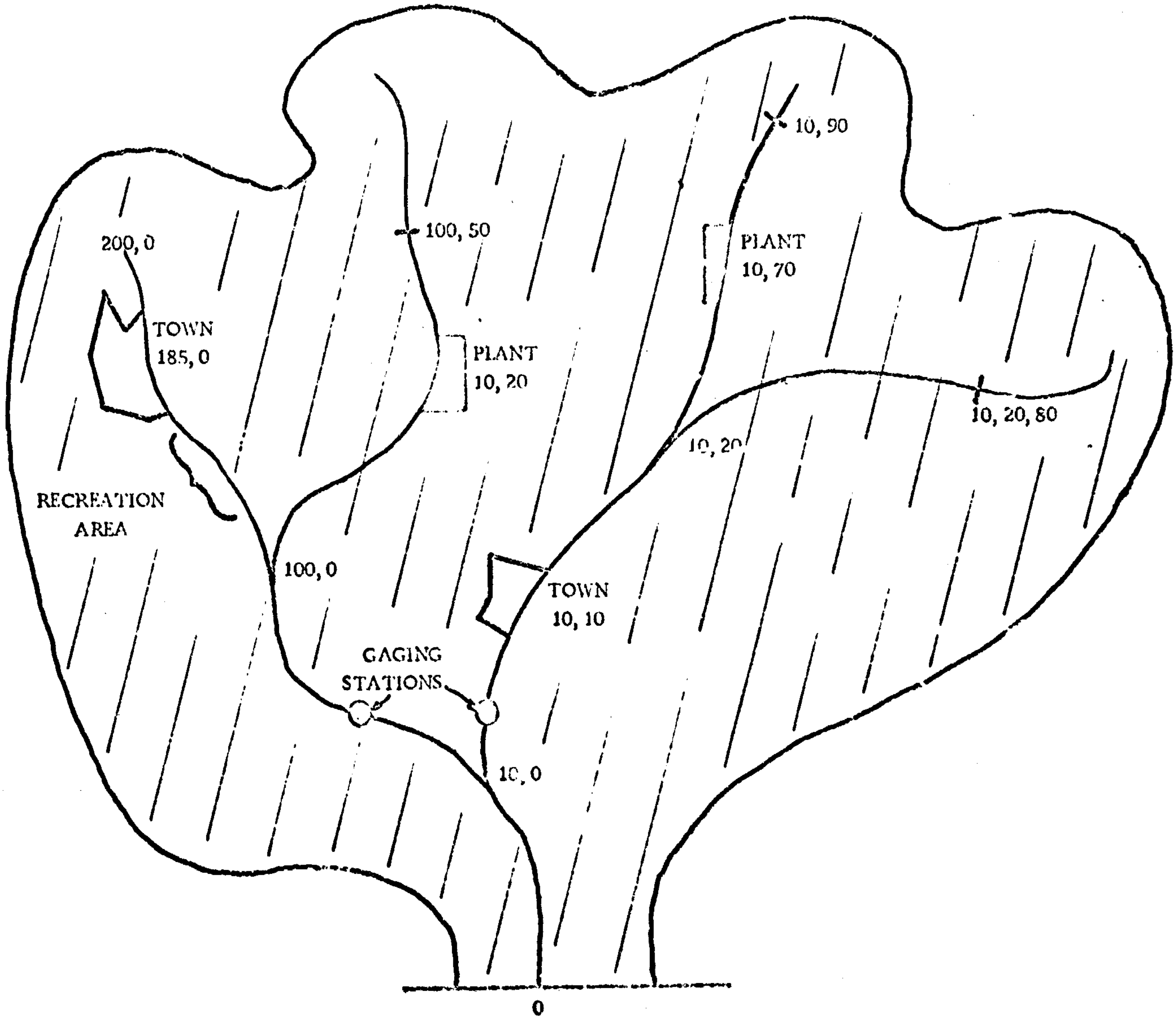

10, 90
200, 0
100, 50
PLANT
10, 70
TOWN
185, 0
PLANT
10, 20
10, 20, 80
10, 20
RECREATION
AREA
100, 0
TOWN
10, 10
GAGING
STATIONS
10, 0
0

FIGURE B

2. Continue numbering from the uppermost point on the tributary encountered in number 1 above. If junctions are encountered as the uppermost point is sought, select any branch and resume the numbering from its uppermost point. Thus, point 4 and 5 are located, but care must be taken to number each junction only once so that the sequence jumps over the junction (point 3) to which a number is already assigned.

3. Continue downstream, numbering each point, until another junction is encountered. Thus, point 6 is located. Now continue as in number 2 noting that the upstream junction allows the choice of branch for point 7. The left branch is selected, so that points 7 and 8 follow directly; point 9 is a junction whereupon 10 becomes the right-hand branch.

4. Points 11 and 12 follow in order, but a previous junction (point 6) now intervenes so that the end point, downstream of the junction at point 6, is assigned number 13.

The following rules describe how the program locates the next point to be considered, assuming that the current coordinate is the i^{th} from among N points.

1. A vector containing N elements is punched. The i^{th} element is the coordinate of the $(i+1)^{st}$ point, this necessarily being the next downstream point.

2. A junction point appears twice in this vector. That is, it is downstream of 2 distinct coordinates.

3. Starting points in each branch do not appear because they are not downstream from any point.

4. The element corresponding to the terminal point is assigned zero. Note that this is not necessarily the N^{th} element because it is possible that the terminus will not be the last numbered or N^{th} coordinate.

All junctions define an additional vector whose elements are the coordinates of the starting or uppermost points of the tributary encountered above.

Referring to Figure C, the vector of next points is [2,3,6,5,3,13,8,9,11,9,12,6,0].

The underscored elements are junctions, and appear twice. Starting points [1,4,7,10] do not appear, and the N^{th} or 13th value is zero. The vector of starting points for each junction is [4,7,10].

Starting point [1], being the initial or beginning point in the system, is defined by other input.

The program considers the following transformed system of streams and components

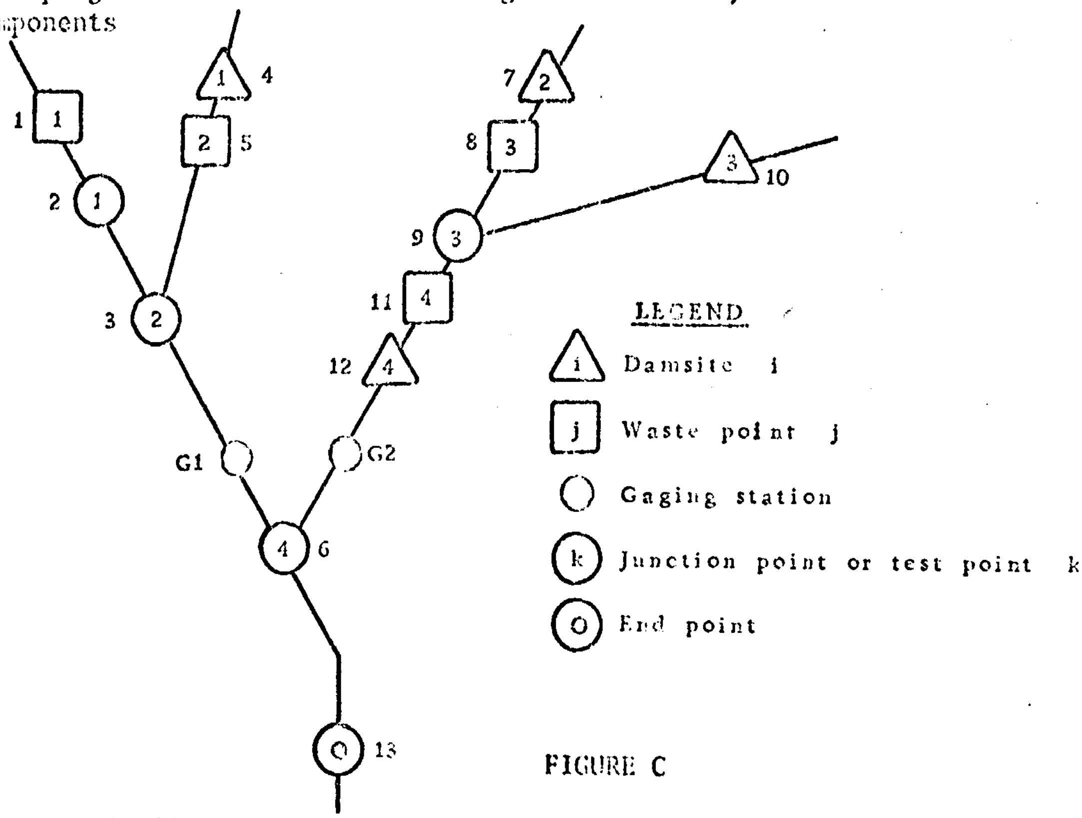


FIGURE C

Flows and effluent flux rates are referenced to a set of discrete points which represent continuous zones or reaches of the prototype. While this is a departure from reality, the errors introduced by concentrating the processes of a basin into a set of point processes are almost surely within the uncertainties and errors propagated by inaccuracy in the data.

Rules for establishing a coordinate system for system specification are:

1. Start from the uppermost point on any branch and number the points consecutively down to and including the first junction point. Consider the westernmost branch of Figure C to be the starting branch, so that points, 1, 2, and 3 are located directly; the process is interrupted at point 3 because it is a junction point.

B. Relation of coordinates to flow gages.

As many as 50 gaging stations may be used; Option NMP is limited to 25 sites so that if long operational traces are desired Option B is constrained to 25 gages. A vector of N elements is punched, the i^{th} element being the gage number to which the i^{th} point or coordinate is referenced. The gaging stations are not included in the coordinate system. An additional vector provides drainage area factors so that the flow at any gage can be scaled linearly.

Two options are available to scale the gaging station flows. For the first option, the i^{th} drainage area factor multiplied times the flow of the referenced gage defines the flow between the i^{th} point or coordinate and the (i-1) coordinate or the point directly upstream. This option is used when the gaging stations are located on the tributaries. If the second option is specified, then the i^{th} drainage area factor multiplied times the gage flow defines the total inflow into the coordinate.

C. Testing Different Plans

Because the input deck is large, it is useful to be able to evaluate additional plans using the same system configuration by changing the original design cards. Under input control they may be entirely replaced, slightly altered (a few cards changed), or left intact. Each additional plan comprises a run. Each run may use new hydrologic inputs or may be instructed to relocate those same flow data used in earlier runs so that system performance can be compared under the same stochastic regime.

D. Wastes or Pollutants.

Five waste variables may be considered simultaneously in the program. They may be introduced at up to 10 points. The pollutants are characterized by seasonal means and standard deviations. A stochastic component is added to the expectations of both waste flow and waste weight, the magnitudes being proportional to the specified respective standard deviations.

Three different types of pollutants may be considered. The first are conservative pollutants having no counterparts in the natural or ambient system; for example, industrial wastes such as chromates. These wastes are imposed upon a system having zero natural concentrations. The second are conservative pollutants having counterparts in the natural system. Typical examples would be agricultural and industrial wastes that include pollutants such as total dissolved solids, boron, chlorides, and sulfates. Lastly, a degradable pollutant such as B.O.D. may be considered. For this type of waste the background or natural concentration may be included.

The program routes up to 5 wastes by attempting to maintain target (maximal) concentrations at the several test and use points. In addition, an unspecified pollutant or set of pollutants can impose a minimum flow requirement (determined externally) which the system seeks to maintain. Dissolved oxygen standards are commonly treated in this fashion.

Only one degradable waste may be specified, and if so, it is defined to be waste number one. For the other wastes (type 1 or type 2) the order is not important. However, once an order is established, it must be the same for all waste sites. Furthermore, the same order must be maintained for the water quality standards or targets at the test sites.

For each conservative pollutant (type 2), the background concentration of the unregulated inflow at each coordinate in the system is calculated by one of two options. The first option uses log concentration versus log flow regression equations. The parameters of these regression equations are required as input. They are determined from the analysis of the historical streamflow and quality observations. Also required as input are the upper and lower concentration limits for each relationship. These limits are determined from observation of the historical data.

For the second option, streamflow and water quality monitoring stations are simulated simultaneously in option NMP. In option B the concentration at each site is computed from the simulated water quality at the monitoring stations by linear regression. The parameters of these relationships are required as input. These are determined from the analysis of historical quality observations.

If a degradable waste is specified, the following information is required:

1). Natural or background concentration for each point; this is the load introduced from the unregulated flow.

2) Mean seasonal temperature (°C.).

3) River miles from each coordinate to next coordinate.

4) The program computes a velocity V in miles per day from the relationship $V = a\,Q^b$, where a and b are required as inputs for each site.

5) Deoxygenation coefficients (20°C.) for each point and for each dam site.

In Figure C, the waste points are numbered [1,2,3,4].

E. Dam Sites

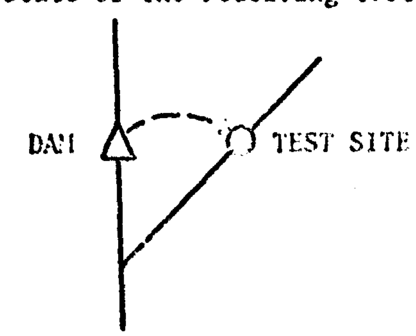
For each of 15 or fewer sites, the capacity, minimum pool storage, and starting active storage are required. Perfect mixing is assured in reservoirs and is accomplished before releases are made. As an option the combined reservoir losses resulting from evaporation and seepage can be considered.

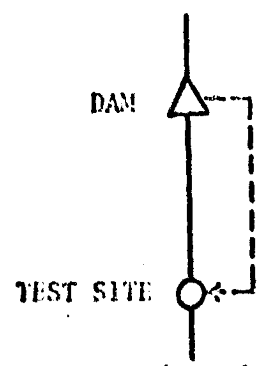
In Figure C, the dams are numbered (1,2,3,4) as shown.

F. Reservoir withdrawal and release options

A series of choices may be selected to operate any reservoir in the system. Any reservoir may operate by combination of these choices; however, the priority of the options is fixed for all reservoirs by the program. During each time frame the program performs an initial routing using only choice 1 and choice 2. If supplemental flow needs arise in the basin and if either of the latter two choices have been specified, then the program performs several additional routings using all the specified choices to satisfy flow requirement needs.

1. Explicit (pipeline) withdrawal. Seasonal quantities of water and its quality may be withdrawn (pipeline) from any reservoir and mixed and blended at a test site. The addition of water is made regardless of the state of the receiving test site. Consider the following:





Shown in both applicable examples is a reservoir and a test site.

Rule: The streamflow at the test site must not enter the dam site. The dam must be encountered prior to the test site during the routing.

The typical operation for a resrvoir using this choice is the following:

1) The current inflow and start of the season storage are added and the quality of the contents blended.

2) The evaporation loss or rainfall addition is then considered and the quality re-constituted.

3) The required diversion is then withdrawn from the total assets.

4) If no other release option has been specified, then continuity is checked.

5) When the test site is encountered in the routing, the diversion is added to the flow at the test site and the qualities blended.

The seasonal quantities to be withdrawn are required as input for each reservoir. Required also is a vector relating the locations of the receiving test sites to that of the reservoirs.

2. Operating rules. Any reservoir may be operated by the following seasonal linear regression relationships:

$$D_i = A_i + B_i * Q_i + C_i * S_i \qquad i = \text{season}$$

where D_i, Q_i, and S_i are the seasonal draft, inflow, and storage, respectively. A_i, B_i, and C_i are inputed for each reservoir.

A reservoir may be maintained at a certain pool level by setting B_i and C_i equal to zero and letting A_i equal the percentage of total capacity implied by that pool elevation. A_i is inputed as a negative decimal. Recreational and flood control pool elevation rules may be expressed in this manner.

To map the operation of existing reservoirs into a system, perform regression analysis on the observed inflows, storage volumes, and releases. The computed coefficients, A_i, B_i, and C_i may then be inputed to the program. Note that the effects of evaporation for the existing reservoirs is already implicit in these coefficients.

Minimum flow release for fish protection or navigation may be accomplished by setting B_i and C_i equal to zero and letting A_i equal the minimum required release.

Typical operation is the following:

1) The current inflow and start of the season storage are added and the quality of the contents blended.

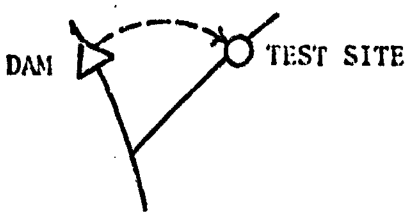
2) The evaporation loss or rainfall addition is then considered and the quality re-constituted.

3) If an explicit diversion is specified, it is withdrawn.

4) Release computed from the seasonal rule is then drafted.

5) Continuity is checked.

3. <u>Conditional pipeline diversions</u>. Any test site may receive additional waters to satisfy a minimum flow requirement and/or water quality standards. This choice differs from the first in that the conditions at the test sites are first investigated to see if supplemental waters are needed. Consider the following example:



Shown in the example is a test site and a reservoir. The test site represents a city having a water supply flow requirement. The city obtains its water supply from the runoff above it and draws upon the reservoir only when the natural source is deficient.

<u>Rule</u>: The dam site must be encountered prior to the test site during the routing.

Typical operation is the following:

1) Explicit withdrawal is considered first.

2) Release defined by the operating rule (choice 2) is then drafted. In absence of choice 1 and choice 2, the reservoir contents are checked for continuity. Excesses are released and proceed downstream of the reservoir.

3) The supplemental requirement is then withdrawn from the reservoir.

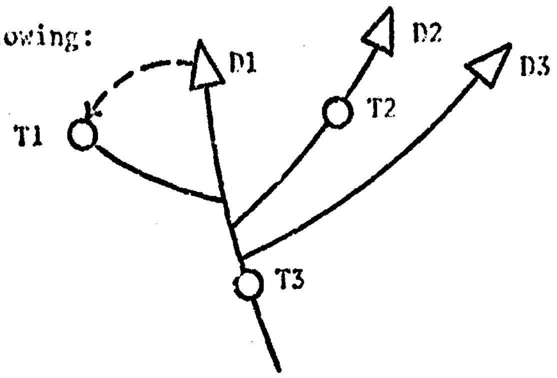
4) When the test site is encountered in the routing, the diversion is added to the flow at the test site and the qualities are blended.

A vector relating the locations of the test sites receiving supplemental flows to that of the reservoirs is required as input.

4. <u>Conditional channel releases</u>. Any test site downstream from a group of reservoirs (≤ 10) can draw from the storage of these reservoirs when a need arises to satisfy a minimum flow requirement and/or water quality standards. The releases are made directly into the channel and flow down to the need point. Specifying second tier reservoirs, that is, reservoirs in series, is not allowed. Flows released to satisfy headwater needs are considered in computing the supplemental requirements of the downstream test sites.

Three alternatives are available to distribute a need among a series of reservoirs: 1) Demand is evenly split, 2) Demand is proportionally split by the available storage in each of the reservoirs, 3) Demand is satisfied by sequentially depleting a series of reservoirs. The order of depletion is specified by input.

Consider the following:



Shown in the example are three reservoirs and three test sites having minimum flow requirements. Reservoirs two and three have recreational and flood control pool elevation rules. Test site one may receive a conditional pipeline diversion from reservoir one. Test sites two and three may draw upon reservoirs two and three respectively when the flow requirements are not satisfied.

The flow requirement at test site two is compared with the local inflows into that site plus any releases made to maintain the pool level of reservoir two. If the flow requirement is not satisfied then additional waters are released from reservoir two.

For test site three, the flow requirement is compared with the sum of: a) all local flows between the dams and the test site; b) the conditional diversion withdrawn for test site one; c) the sum of all releases made to either maintain continuity or satisfy the pool level rules; and d) any additional release required to satisfy test site two. If a deficiency occurs, then this amount is released by reservoir three.

5. Combination of choices and priority. Any reservoir may be operated by any combination of the stated choices; however, the priority of releases is fixed for all reservoirs by the program. The following is the priority followed: 1) explicit pipeline diversions, 2) operating rule release-continuity, 3) conditional pipeline diversions, and 4) conditional channel releases.

6. Test Points. All test points, including all junction points, require ... ements of a flow target and seasonal quality targets for each ... te variable. Three different types of flow targets may be considered. The fi... are instream minimum flow requirements. Common examples are mini... flows for maintaining dissolved oxygen standards, for ensuring fish pas... ... spawning, and for enhancing recreational areas. The second are

minimum flow withdrawals; that is, amounts of water that are exhausted from the system. Often cities receive their water supply by diverting waters from another basin. Deficiencies for both are defined as missing or not maintaining the flow target. The third type is an instream flow requirement but differs from the first in that the deficiencies are defined as excesses above the target flow. Here the flow requirement may be the channel capacity of a reach where flood damages can be roughly assessed. The program does not attempt to minimize these excesses; it only tabulates them. Figure C shows four test points in the system.

CARD INPUT FOR OPTIONS D, EMP, AND B

Input to the options is arranged according to the following descriptions, where:

The symbol *	denotes that a series of cards as described may be needed.
The notation R	indicates "right hand justified", i.e., any quantity so described must appear as far as possible to the right of its data field,
The symbol .	indicates that a decimal point must appear in the field, and
The combination R.	indicates that the value is right-hand justified integral, but may have, if necessary, a decimal point punched in any column to override the programmed decimal which exists at the extreme right-hand boundary of the field.
The symbols	indicate the start of a new card or the continuation of fields on the same card.

INPUT FOR OPTION D

CARD	COLUMNS	DESCRIPTION
1	1-72	Title of Study.
2	1-5R	Years of historical record. ($\leq$100).
	6-10R	Seasons per year (1,2,3,4,6, or 12).
	11-15R	Year in which historical record begins.
	16-20R	Calendar season corresponding to season 1 of input. For example, the USGS water year begins in October, so that if the historical data were obtained from Geological Survey compilation reports, this parameter would be 10.
*3	1-6R.	Historical flow at gaging station, year 1, season 1.
	7-12R.	Historical flow at gaging station, year 1, season 2.
	.....	.....
	67-72R.	Historical flow at gaging station, year 1, season 12.
	.....	
	1-6R.	Historical flow at gaging station, year 2, season 1.
	.....	.....
	.....	Historical flow at gaging station, last year, last season.
4	1-6R.	Factor by which flows for season one are multiplied to convert them from gage to dam site.

	7-12R.	Factor for season 2.
	.....	.....
	.....	Factor for last season
5	1-6R.	Factor by which inflows at dam site are multiplied to compute local (unregulated) flows between dam site and use point for season 1.
	7-12R.	Factor for season 2.
	.....	.....
	.....	Factor for last season.
6	1-5R	Number of seasonal flow requirement vectors.
	6-10R	Years of operational (synthetic) hydrology to be routed through the proposed reservoir.
	11-15R	Number of reservoir sizes. (≤10).
	16-20R	Random number generator trigger. Any odd integer greater than zero.
	25	Reservoir operating policy modes. 1-Meet downstream dilution requirement. 2-Rule curves. 3-Rule curves with constraint to meet downstream flow requirement.
	30	If each synthetic trace is to be identical for each routing, punch 1.
	35	If the historical record routing is to be deleted, punch 1.
7		<u>Print suppress.</u> Punch 1 if not desired. Historical record analysis.
	2	Statistics of one-season misses, punch 1.
	4	Statistics of annual misses, punch 1.

6	Statistics of consecutive seasonal misses (36 seasons - maximum duration), punch 1.
8a	Seasonal and annual failure histograms in tabular form, punch 1.
8b	Seasonal and annual failure histograms in both tabular and graphic form, punch 2.
10a	Seasonal histograms of storage levels in tabular form, punch 1.
10b	Seasonal histograms of storage levels in both tabular and graphic form, punch 2.
12	Seasonal statistics of flows past test point, punch 1.
	Synthetic trace analysis
14	Statistics of one-season misses, punch 1
16	Statistics of annual misses, punch 1.
18	Statistics of consecutive seasonal misses, (36 seasons — maximum duration), punch 1.
20a	Seasonal and annual failure histograms in tabular form, punch 1.
20b	Seasonal and annual failure histograms in both tabular and graphic form punch 2.
22a	Seasonal histograms of storage levels in tabular form, punch 1.
22b	Seasonal histograms of storage levels in both tabular and graphic form, punch 2.
24	Seasonal statistics of flows past test point, punch 1.
26	Yearly, grand, and seasonal statistics of up to first 100 years of synthetic trace.

8	1-6R.	Size of first trial reservoir. (units must be consistent with streamflow).
	7-12R.	Size of second trial reservoir.
	.....	.....
9	1-6R.	Starting storage of first trial reservoir.
	7-12R.	Starting storage of second trial reservoir.
	.....	.....
	55-60R.	Starting storage of last trial reservoir.
		If reservoir release mode 1 is exercised, skip *10.
*10		Reservoir release rule input. 1). Release (season) = A(season)+ B(season)* Inflow(season) + C(season)*Storage(season). 2). For a pool level rule, B(season) and C(season) must be zero. A(season) = -Percentage of capacity. (decimal) 3). Rules are the same for each trial reservoir.
	1-6R.	Coefficient A, season 1.
	7-12R.	Coefficient A, season 2.
	.....	.....
	.....	Coefficient A, last season.
	.....	
	1-6R.	Coefficient B., season 1.
	7-12R.	Coefficient B, season 2.
	.....	.....
	.....	Coefficient B, last season.
	.....	
	1-6R.	Coefficient C., Season 1.
	7-12R.	Coefficient C, season 2.
	.....	.....

	.....	Coefficient C, last season.
11	1-72	Description of dilution requirement vector.
12	1-6R.	Mean dilution requirement, season 1.
	7-12R.	Mean dilution requirement, season 2.
	.....	.....
	67-72R.	Mean dilution requirement, last season.
13	1-6R.	Standard deviation dilution requirement, season 1.
	7-12R.	Standard deviation dilution requirement, season 2.
	.....	.....
	67-72R.	Standard deviation dilution requirement, last season.
14	1-6R.	Diversion, season 1. (evaporation or any loss of storage at reservoir site). An addition to the contents of the reservoir is implied, if the field is prefixed with a negative sign.
	7-12R.	Mean diversion, season 2.
	.....	.....
	.....	Mean diversion, last season.
15	1-6R.	Standard deviation diversion, season 1.
	7-12R.	Standard deviation diversion, season 2.
	.....	.....
	67-72R.	Standard deviation diversion, season 12.

REPEAT CARDS 11-15 FOR EACH DILUTION VECTOR.

RETURN TO CARD 6 FOR A NEW SET OF RESERVOIRS AND DILUTION VECTORS.

RETURN TO CARD 1 FOR NEW STUDY.

INPUT FOR OPTION NMP

CARD	COLUMNS	DESCRIPTION
1	1-72	Name of River Basin
2	1-5R	Years of historical record (≤100)
	6-10R	Seasons per year (1, 2, 3, 4, 6, or 12)
	11-15R	Number of gaging sites (≤25)
	16-20R	Years of operational hydrology or quality
	21-25R	Random Number Trigger Any odd integer excluding zero
3*	1-72	Name of gaging site 1
	...	Name of last gaging site
4*		Flow or Quality Data
		Site 1, Year 1
	1-6R.	Quality or flow for season 1
	7-12R.	Quality or flow for season 2
	...	...
	67-72R.	Quality or flow for last season
	...	
		Site 1, Year 2
	1-6R.	Quality or flow for season 1
	...	...
	....	Quality or flow for last season
		Site 1, Last Year
	1-6R.	Quality or flow for season 1
	7-12R.	Quality or flow for season 2
	...	...
	...	...

CARD	COLUMNS	DESCRIPTION
		Last site, last year.
	1-6R.	Quality or flow for season 1
	...	...
	...	Quality or flow for last season

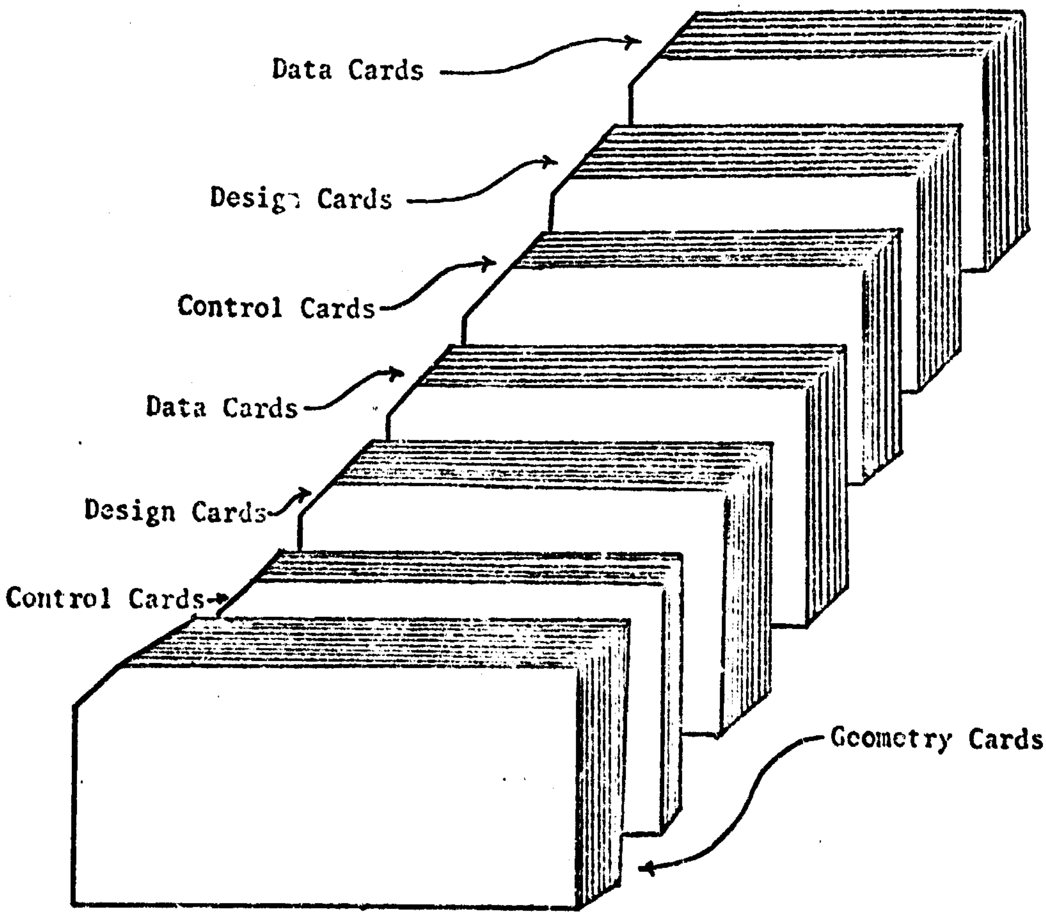
INPUT FOR OPTION B (See following page for typical input arrangment).

A. *Geometry Cards

Card	Columns	
1	1-72	Title or identification
2	4-5R	Number of coordinates ≤50
	9-10R	Starting point coordinate
	14-15R	Seasons per year (1,2,3,4,6,12)
	19-20R	Number of gaging stations ≤50, but ≤25 if flows are generated previously in Model NMP. Note: If both stream flows and water quality (conservative) have been generated, punch the sum, ≤25.
	24-25R	Number of complete runs (number of plans to be investigated)
*3		Up to five cards may be needed
		Type of point or coordinate
		1 - Test point ≤15.
		2 - Waste point ≤10
		3 - Dam site ≤15
		4 - Junction point ≤10
		5 - End point (only one)
	5	Type for coordinate 1.
	10	Type for coordinate 2
	.....	...
	50	Type for coordinate 10
	.....	
	5	Type for coordinate 11
	.....	....
	.....	Type for last (Nth coordinate)

*Supply card with a 5 punched in column 1.

Geometry cards include: *1-*7
Control cards include : 8,*9,*10
Design cards include : *11-*24, 47* - *49
Data cards include : *25-* 46



OPTION B
TYPICAL INPUT CARD
ARRANGEMENT

		Up to five cards may be needed.
		<u>Next</u> <u>Point</u> cards
*4		
	4-5R	Coordinate number directly downstream of the first coordinate.
	9-10R	Coordinate number directly downstream of the second coordinate.
	....	....
	49-50R	Coordinate number directly downstream of the tenth coordinate.
	....	
	4-5R	Coordinate number directly downstream of the eleventh coordinate.
	.....	.....
	.....	Last coordinate - punch zero.
*5		Up to five cards may be needed.
	4-5R	Gaging station to which first coordinate is referred.
	....	....
	.....	.....
	49-50R	Gaging station to which tenth coordinate is referred..
	....	
	4-5R	Gaging station to which eleventh coordinate is referred.
	.....	.....
	....	Gaging station to which last coordinate is referred.
*6 A		Up to ten cards may be needed.
		See S-30.
	1-10R	Drainage area ratio referring coordinate I to its respective gaging station. (This ratio accounts only for the inflow between coordinate (I) and coordinate (I - 1)). At junction point the ratio accounts for inflow below both tributary coordinates.
	.....	

	41-50R.	Drainage area ratio referring coordinate 5 to its respective gaging station. (This ratio accounts only for the inflow between coordinate (i) and coordinate (i-1)).
	.....	
	1-10R.	Drainage area ratio referring coordinate 6 to its respective gaging station. (This ratio accounts only for the inflow between coordinate (i) and coordinate (i - 1)).
	.....	.....
	....	Drainage area ratio referring last coordinate. (This ratio accounts only for the inflow between coordinate (i) and coordinate (i - 1)).
*6B		
	1-10R.	Drainage area ratio referring coordinate 1 to its respective gaging station. (This ratio accounts for the total inflow into this coordinate.)
	11-20R.	Drainage area ratio referring coordinate 2 to its respective gaging station. (This ratio accounts for the total inflow into this coordinate.)
	.....	.....
	....	
	1-10R.	Drainage area ratio referring coordinate 6 to its respective gaging station. (This ratio accounts for the total inflow into this coordinate.)
	.....	.....
	.....	Drainage area ratio referring last coordinate to its respective gaging station. (This ratio accounts for the total inflow into this coordinate.)
7	4-5R	Starting point of complimentary branch for junction point 1.
	9-10R	Starting point of complimentary branch for junction point 2.
	....	.....

Starting point of complimentary branch for last junction point 10.

Note: Path of movement is conditional upon starting point.

B. Control Cards

Card	Columns	
CARDS BEYOND THIS POINT ARE NEEDED FOR EACH RUN		
8	1-5R	Number of years of historical or generated record.
	10	Number of waste variables ≤5, (1,2,3,4, or 5) Waste sites with zero waste variables are permitted.
	15	Logical tape unit for input flows. If card input, use 5; if binary tape input, use 4. Card input implies usage of historical flows. Binary tape input means that a tape of operational hydrology has been previously prepared in Option NMP.
	17-20R	Sequential year on the flow tape. reckoned from the start, at which routing will begin. The flow tape (binary) will be rewound at the end of each plan.
	25	Multi-run key. If single run, punch zero. If multi-run, punch zero for first run and one for subsequent runs. It is desirable after the initial run to change only a few design parameters and proceed without having to replace the entire deck starting with this card. If this choice is exercised, include card 9, then skip to card *48. If historical flows are used, they must be included for each run and after the design update cards. If this choice is not exercised, then replace deck from this card.

30 If gaging station scaling factors (*6) have been prepared by choice A, punch zero. If prepared by choice B, punch 1.

35 If any reservoir(s) are to make explicit pipeline diversions to any test sites, punch 1.

40 If any reservoir(s) are to make conditional pipeline diversions to any test sites, punch 1.

41-45R Random number generator trigger. Any odd integer greater than 0.

50 Allocation alternatives for reservoirs serving pre-specified downstream test sites. Only applicable when more than one reservoir has been specified to serve a downstream test site.
Punch:
1-even split
2-apportion by available storage(space rule)
3-sequential depletion. Priority is specified by entry order in *22.

55 Mode of calculating conservative pollutant concentrations.

A. If no conservative pollutants are considered in analysis, punch zero.
B. If background salt concentrations are to be calculated by exponential regression equations using streamflow, punch 1.

$$L_{ij} \geq C_{ij} = A_{ij} Q_i^{B_{ij}} \leq T_{ij} \quad \text{i-coordinate index}$$

where $A_{ij}, B_{ij}, L_{ij}, T_{ij}$ are input. j-pollutant index

C. If salt concentrations at water quality monitoring watering stations are simulated together with streamflows in Model NMP, then punch 2. Only one pollutant is permitted by this option. Background conservative concentrations at each of the system co-ordinates are calculated by linear regression on simulated water quality monitoring station variates:

$C_i = A_i + B_i C_k + t*STD.ERR.EST._i$ i-coordinate index
k-water quality monitoring station index

where A_i, B_i, STD.ERR.EST.$_i$ are input
$t \sim N(0,1)$

60 If any of the test points or junction points are to consider excess flows above a pre-specified target flow (channel capacity), then punch 1. The same statistical summary output for excesses or deficiencies will be provided.

65 If evaporation at dam sites is desired, punch 1.

*9 Printing suppress option. Punch 1 if not desired.

5 Seasonal supplemental flow histograms associated with pollutant 1.

10 Seasonal supplemental flow histograms associated with pollutant 2.

15 Seasonal supplemental flow histograms associated with pollutant 3.

20 Seasonal supplemental flow histograms associated with pollutant 4.

25 Seasonal supplemental flow histograms associated with pollutant 5.

30 Seasonal supplemental flow histograms associated with pre-specified target flows.

35 Maximum seasonal supplemental flow histograms.

40 Seasonal means, standard deviations and probabilities of supplemental flows associated with pollutant 1.

45 Seasonal means, standard deviations and probabilities of supplemental flows associated with pollutant 2.

50 Seasonal means, standard deviations and probabilities of supplemental flows associated with pollutant 3.

...

	5	Seasonal means, standard deviations and probabilities of supplemental flows associated with pollutant 4.
	10	Seasonal means, standard deviations and probabilities of supplemental flows associated with pollutant 5.
	15	Seasonal means, standard deviations and probabilities of supplemental flows associated with pre-specified target flows.
	20	Maximum seasonal means, standard deviations and probabilities of supplemental flows.
	25R	Yearly means, standard deviations, probabilities and histograms of supplemental flows.
	30R	Seasonal means and histograms of reservoir storage.
	35R	Seasonal means, standard deviations, and histograms of system flows. Grand means and standard deviations of system flows.
	40R	Seasonal means and standard deviations of pollutant concentrations at test sites. Time-invariant histograms.
	45R	Time-invariant histograms of pollutant concentrations at dam sites. Seasonal means and standard deviations of pollutants.
*10	1-72	Description of first coordinate.
	1-72	Description of second coordinate.
	.....	
	1-72	Description of last coordinate.

C. Design Cards

Card	Columns	
*11		Up to three cards may be required. Order of the dam sites has already been established by cards *4 and 7. Follow that order.
	1-10R.	Capacity of dam 1(same units as stream flow).
	11-20R.	Capacity of dam 2.
	.....	.....
	41-50R.	Capacity of dam 5.
	.....	
	1-10R.	Capacity of dam 6.
	.....	.....
	.....	Capacity of last dam.
*12		Up to three cards may be required.
	1-10R.	Dead storage, dam 1.
	11-20R.	Dead storage, dam 2.
	.....	.....
	41-50R.	Dead storage, dam 5
	....	
	1-10R.	Dead storage, dam
	....	.....
	.....	Dead storage, last dam.
*13	1-10R.	Initial storage, dam 1.
	11-20R.	Initial storage, dam 2.
	.....	

41-50R. Initial storage, dam 5.

.....
1-10R. Initial storage, dam 6.

....

..... Initial storage, last dam.

NOTE: Units of streamflows, capacities, diversions, flow requirements, and waste volumes must be made consistent external to the program.

*14 Reservoir rule curves.
General expression for draft during any season:
$D_i = A_i + B_i Q + C_i S_i$ i = seasonal index

where A_i, B_i, C_i are input

If B_i & C_i = 0, and A_i less than 0, (negative decimal) then a percentage of capacity(pool level rule) is implied.

1-10R. Coefficient A, season 1, dam 1.

11-20R. Coefficient A, season 2, dam 1.

....

51-60R. Coefficient A, season 6, dam 1.

.....

1-10R. Coefficient A, season 7, dam 1.

....

51-60R. Coefficient A, season 12, dam 1.

.....

1-10R. Coefficient B, season 1, dam 1.

....

51-60R. Coefficient B, season 6, dam 1.

.....

1-10R. Coefficient B, season 7, dam 1.

....

	51-60R.	Coefficient B, season 12, dam 1.
	.....	
	1-10R.	Coefficient C, season 1, dam 1.
	11-20R.	Coefficient C, season 2, dam 1.
	.....	.....
	51-60R.	Coefficient C, season 6, dam 1.
	.....	
	1-10R.	Coefficient C, season 7, dam 1.
	.....	.....
	51-60R.	Coefficient C, season 12, dam 1.
		Cycle for all dams.
*15		If explicit (transbasin) diversion choice is exercised (8-35), include this card(s).
	4-5R	Location of test site (test points and confluence points) that dam 1 is to make diversions to.
	9-10R	Location of test site that dam 2 is to make diversions to.
	.....	.....
	49-50R	Location of test site that dam 10 is to make diversions to.
	.....	
	4-5R	Location of test site that dam 11 is to make diversions to.
	....	....
	....	Location of test site that last dam is to make diversion to.
*16		Explicit mean diversion for each dam.

1-10R.	Diversion, dam 1, season 1.
11-20R.	Diversion, dam 1, season 2.
.....	.....
51-60R.	Diversion, dam 1, season 6.
.....	
1-10R.	Diversion, dam 1, season 7.
.....	.....
51-60R.	Diversion, dam 1, season 12.
	Cycle for all dams.

*17 Units must be made consistent external to program. If conditional diversion option (8-40) is exercised, include this card(s).

4-5R	Location of test site that dam 1 will supplement with diversions when needed.
.....	.....
49-50R	Location of test site that dam 10 will supplement with diversions when needed.
.....	
4-5R	Location of test site that dam 11 will supplement with diversions when needed.
.....	.....
.....	Location of test site that last dam will supplement with diversions when needed.

NOTE: If no waste variable is specified (although waste sites may be specified) skip to card #21. All waste volumes are waste flow rates. All waste weights are the waste volume rates times the concentration of the respective pollutants. Order of waste sites has already been established by cards #4 and 7. Follow that order.

*18	1-10R.	Minimum volume, site 1.
	11-20R.	Minimum volume, site 2.
	.....	.....
	41-50R.	Minimum volume, site 5.
	. ...	
	.....	Minimum volume, last site.
19	1-10R.	Minimum pollutant weight, waste 1, site 1.
	11-20R.	Minimum pollutant weight, waste 2, site 1.
	.....	.....
	41-50R.	Minimum pollutant weight, waste 5, site 1.
	.....	
		Start new waste site.
		Note: Cards *18 and *19 constrain stochastic waste pollutant volume and weights to minimum input values. Punch zeros if the respective standard deviations in *20 are zero.
*20		Seasonal moments of waste volume.
	1-10R.	Total mean volume, waste site 1, season 1.
	11-20R.	Total mean volume, waste site 1, season 1.
	.....	.....
	51-60R.	Total mean volume, waste site 1, season 6.
	.....	
	1-10R.	Total mean volume, waste site 1, season 7.
	11-20R.	Total mean volume, waste site 1, season 8.
	.....	.....
	.....	Total mean volume, waste site 1, last season.
	.....	

1-10R.	Standard deviation of volume, waste site 1, season 1.
11-20R.	Standard deviation of volume, waste site 1, season 2.
.....	.....
51-60R.	Standard deviation of volume, waste site 1, season 6.
.....	
1-10R.	Standard deviation of volume, waste site 1, season 7.
11-20R.	Standard deviation of volume, waste site 1, season 8.
.....	.....
.....	Standard deviation of volume, waste site 1, last season.
.....	
	Seasonal moments of pollutant weights.
1-10R.	Mean weight of waste 1, season 1.
11-20R.	Mean weight of waste 1, , season 2.
.....	.....
51-60R.	Mean weight of waste 1, , season 6.
.....	
1-10R.	Mean weight of waste 1, , season 7.
.....	.....
.....	Mean weight of waste 1, last season.
.....	
1-10R.	Standard deviation of weight for waste 1, season 1.
11-20R.	Standard deviation of weight for waste 1, season 2.
.....	.....
51-60R.	Standard deviation of weight for waste 1, season 6.
......	
1-10R.	Standard deviation of weight for waste 1, season 7,
.....	.....

	.....	Standard deviation of weight for waste 1, last season.
		Repeat for each waste variable then start at next waste site.
		Three cards may be necessary.
*21		Number of 1st tier dams upstream serving downstream test points and junction points (≤ 10). Order of test sites has already been established by cards *4 and 7. Follow that order. *
	1-5R	Number of dams serving test point or junction point 1.
	6-10R	Number of dams serving test point or function point 2.
	.....	.....
	46-50R	Number of dams serving test point or junction point 10.
	.....	
	1-5R	Number of dams serving test point or junction point 11.
	.....	.....
	.....	Number of dams serving last test point (junction point).
		25 cards may be required. Location of dams serving test points. If no dams serve test point, then skip that card.
*22	1-5R	Location of dam 1 serving test point 1.
	6-10R	Location of dam 2 serving test point 1.
	11-15R	Location of dam 3 serving test point 1.
	.....	.....
	.....	Location of last dam serving test point 1.
	.....	
	1-5R	Location of dam 1 serving test point 2.
	.....	.....
	.....	Location of last dam serving last test point.

*Junction points are included in the ordering scheme after both branches have been completed.

23 350 cards may be necessary. Seasonal moments of flow requirement and seasonal targets for each waste variable at each test point.

	Test Point 1.
1-10R.	Mean flow requirement, season 1.
11-20R.	Mean flow requirement, season 2.
.....	.....
51-60R.	Mean flow requirement, season 6.
.....	
1-10R.	Mean flow requirement, season 7.
.....	....
.....	Mean flow requirement, last season.
.....	
1-10R.	Standard deviation flow requirement, season 1.
11-20R.	Standard deviation flow requirement, season 2.
.....	.....
51-60R.	Standard deviation flow requirement, season 6.
.....	
1-10R.	Standard deviation flow requirement, season 7.
.....	.....
..	Standard deviation flow requirement, last season.
	Water quality requirements (Standards) for each test point. Units must be consistent with pollutant concentrations. Note; Skip target cards if no pollutant specified.
1-10R.	Target waste 1, season 1.
11-20R.	Target waste 1, season 2.
.....	.....
51-60R.	Target waste 1, season 6.
.....	
1-10R.	Target waste 1, season 7.
.....	.....

	.....	Target waste 1, last season.
		Finish all wastes, then start the same sequence at next test point on junction point.
*24		Option to keep track of flows higher than a specified limit. (Flood flows)
		If 8-60 was non-zero, then include *24
	5	If the flow requirement at test point or junction point 1 is a channel capacity restraint, punch 1.
	10	If the flow requirement at test point or junction point 2 is a channel capacity restraint, punch 1.
	.....	.....
	50	If the flow requirement at test point or junction point 10 is a channel capacity restraint, punch 1.
	.....	
		<u>Evaporation parameter input.</u>
		If card 8-65 was zero then skip to *33.
		2 cards may be necessary.
*25	5	Punch 1 if contents of dam 1 are to be evaporated.
	10	Punch 1 if contents of dam 2 are to be evaporated.
	.....	.....
	50	Punch 1 if contents of dam 10 are to be evaporated..
	.....	
	.....	Punch 1 if contents of last dam are to be evaporated.
26	5	Number of regional seasonal evaporation vectors, ≤ 3. (No conversion of units is performed in program).

*27	1-10R.	Mean evaporation rate for season 1, vector 1.
	11-20R.	Mean evaporation rate for season 2, vector 1.
	.....	.....
	51-60R.	Mean evaporation rate for season 6, vector 1.
	.....	
	.....	Mean evaporation rate for last season, vector 1.
*28	1-10R.	Standard deviation of evaporation rate for season 1, vector 1.
	11-20R.	Standard deviation of evaporation rate for season 2, vector 1.
	.....	.....
	51-60R.	Standard deviation of evaporation rate for season 6, vector 1.
	.....	
	.....	.....
	.....	Standard deviation of evaporation rate for last season, vector 1.
		Repeat cards *27 and *28 for next evaporation vector.
*29		Two cards may be needed.
	5	Evaporation vectors (mean and standard deviation) to which the first dam is to be referred.
	10	Evaporation vector to which the second dam is to be referred.
	.....	.....
	50	Evaporation vector to which 10th dam is to be referred.
	.....	
	.....	Evaporation vector to which last dam is to be referred.

*30		3 cards may be necessary.
	1-10R.	Factor scaling the magnitude of the specified evaporation vector for dam site 1.
	11-20R.	Factor scaling the magnitude of the specified evaporation vector for dam site 2.
	.....	.....
	41-50R.	Factor relating dam 5.
	.....	
	1-10R.	Factor relating dam 6.
	.....	.....
	.....	Factor relating last dam.
*31	1-10R.	Constant in Area-Volume regression, equation for dam 1 (units must be consistent with evaporation vectors). (linear arithmetric regression).
	11-20R.	Constant in Area-Volume regression equation for dam 2.
	.....	.....
	41-50R.	Constant in Area-Volume regression equation for dam 5.
	.....	
	.....	.....
*32	1-10R.	Regression coefficient in Area-Volume regression equation for dam 1.
	11-20R.	Regression coefficient in Area-Volume regression equation for dam 2.
	.....	.....
*33		Up to 15 cards may be needed. For all dam sites where initial storage exceeds zero, the program expects the initial concentration of the specified waste variables. New cards for each dam site. Not all fields need to be used. If no waste variables have been specified, then skip.

	1-10R.	Initial concentration of waste 1, 1st site with storage > 0.
	11-20R.	Initial concentration of waste 2, 1st site with storage > 0.
	21-30R.	Initial concentration of waste 3, 1st site with storage > 0.
	31-40R.	Initial concentration of waste 4, 1st site with storage > 0.
	41-50R.	Initial concentration of waste 5, 1st site with storage > 0.
	.....	
	1-10R.	Initial concentration of waste 1, 2nd site with storage > 0.
	.....	.....
	41-50R.	Initial concentration of waste 5, last site with storage > 0.
34	5	If waste 1 is degradable punch 1; if not, zero.
	10	Number of conservative wastes.
		If 1 is punched in column 5 of card 34, the following cards are required. If zero, skip to *42.
*35		As many as 9 cards may be required.
	1-10R.	Non-conservative pollutant concentration of unregulated flow, point 1.
	11-20R.	Non-conservative pollutant concentration of unregulated flow, point 2.
	.....	.....
	51-60R.	Non-conservative pollutant concentration of unregulated flow, point 6.
	.....	
	1-10R.	Non-conservative pollutant concentration of unregulated flow, point 7.
	.....	.....

		Non-conservative pollutant concentration of unregulated flow, last point.
*36		Two cards may be required.
	1-10R.	Mean temperature (°C), season 1.
	11-20R.	Mean temperature (°C), season 2.
	.....	.....
	51-60R.	Mean temperature (°C), season 6.
	1-10R.	Mean temperature (°C), season 7.
	.....	.....
		Mean temperature (°C), last season.
*37		Nine cards may be required.
	1-10R.	River mile[illegible]e from point to next point.
	11-20R.	River mileage from point 2 to next point.
	.....	.....
	51-60R.	River mileage from point 6 to next point.
	1-10R.	River mileage from point 7 to next point.
	.....	.....
	.....	River mileage last point, punch zero.
*38		Nine cards may be required. Stream velocity is computed from: $V=aQ^b$.
	1-10R.	Constant "a" in equation for velocity at site 1.
	11-20R.	Constant "a" in equation for velocity at site 2.
	.....	.....
	51-60R.	Constant "a" in equation for velocity at site 6.
	1-10R.	Constant "a" in equation for velocity at site 7.
	.....	.....
	.....	Constant "a" in equation for velocity at last site.

*39		Nine cards may be required.
	1-10R.	Constant "b" in equation for velocity at point 1.
	11-20R.	Constant "b" in equation for velocity at point 2.
	.....	.....
	51-60R.	Constant "b" in equation for velocity at point 6.
	.....	
	1-10R.	Constant "b" in equation for velocity at point 7.
	.....	.....
	.....	.....
*40	1-10R.	Deoxygenation coefficient (20°C) at point 1.
	11-20R.	Deoxygenation coefficient (20°C) at point 2.
	.....	.....
	.....	Deoxygenation coefficient (20°C) at last point.
		Three cards may be required.
*41	1-10R.	Deoxygenation coefficient (20°C) at dam site 1.
	11-20R.	Deoxygenation coefficient (20°C) at dam site 2.
	.....	.....
	51-60R.	Deoxygenation coefficient (20°C) at dam site 6.
	.....	
	1-10R.	Deoxygenation coefficient (20°C) at dam site 7.
	.....	.....

If 34-10 is zero, skip to *45

Conservative pollutant background concentrations. If 8-55 was punched 1, use Option 1: if 2, use option 2.

Option 1

The expected value of the concentration for each conservative pollutant at all sites is calculated from the exponential regression on flow:

$$C = dQ^f$$

*42	Option 1	
	1-10R.	"d" in the equation for concentration 1, site 1.
	11-20R.	"d" in the equation for concentration 2, site 1.
	.....	.....
	41-50R.	"d" in the equation for concentration 5, site 1.
	.....	
	1-10R.	"f" in the equation for concentration 1, site 1.
	11-20R.	"f" in the equation for concentration 2, site 1.
	.....	.....
	41-50R.	"f" in the equation for concentration 5, site 1.
	.....	
	1-10R.	Maximum value ("T") of concentration 1, site 1.
	11-20R.	Maximum value ("T") of concentration 2, site 1.
	.....	.....
	41-50R.	Maximum value ("T") of concentration 5, site 1.
	.....	
	1-10R.	Minimum value ("L") of concentration 1, site 1.
	11-20R.	Minimum value ("L") of concentration 2, site 1.
	.....	.....
	41-50R.	Minimum value ("L") of concentration 5, site 1.
		Cycle for all sites
Option 2		Option limited to one conservative pollutant. Simulated stream flows and water quality are on the flow (quality) tape. Caution: check #5 for consistency with *43. All entries in *43 must be different than those in *5.
*43	4-5R	Water quality monitoring station which coordinate 1 is referred.
	9-10R	Water quality monitoring station which coordinate 2 is referred.

	14-15R	Water quality monitoring station which coordinate 3 is referred.
	.....	
	49-50R	Water quality monitoring station wich coordinate 10 is referred.
	.....	
	4-5R	Water quality monitoring station which coordinate 11 is referred.
	.....	Water quality monitoring station which last coordinate is referred.
		Simulated values of the conservative pollutant are calculated for all sites by linear regression on water quality monitoring station variates. See-8-55
*44	1-10R.	Constant in equation for concentration 1 at site 1.
	.....	
	1-10R.	Regression coefficient in equation for concentration 1 at site 1.
	.....	
	1-10R.	Standard Error of Estimate in equation for concentration 1 at site 1.
	.....	Cycle for all sites.
		Up to five cards may be required.
*45	1-6R.	Initial flow at gaging station 1.
	.....	
	7-12R.	Initial flow at gaging station 2.
	.....	.....
	67-72R.	Initial flow at gaging station 12.
	.....	
	.....	.....
	.....	Initial flow at last gaging station.

*46		If input hydrology is on cards, flows at gaging stations in chronological order are needed.
		Year 1 Season 1.
	1-6R.	Flow at gaging station 1.
	7-12R.	Flow at gaging station 2.
	.....	.....
	67-72R.	Flow at gaging station 12.
	....	
	1-6R.	Flow at gaging station 13.
	.....	.....
	.....	Flow at last gaging station.
	.....	
	.....	.....
	.....	
	.....	.....
	.....	
		Last year final season.
	1-6R.	Flow at gaging station 1.
	7-12R.	Flow at gaging station 2.
	.....	.....
	67-72R.	Flow at gaging station 12.
	.....	
	.....	Flow at last gaging station.
*47		Data Supplement Option (Multi-run specification)
		Comment cards. Five are needed.
	1-72	Comment card 1.
	.....	.....
	.....	Comment card 5.

*48		Two cards are necessary. Number of substitutions for each of the "design" and "data" parameters. No geometry card substitutions are permitted. A complete seasonal replacement is counted as one substitution.
		Design cards.
48-A	4-5R	Number of reservoir volume changes.
	9-10R	Number of dead storage changes.
	14-15R	Number of starting storage changes.
		Reservoir rule curve change.
		Draft = A + B*Q + C*S
	19-20R	Number of changes of the seasonal coefficient "A" Note: Complete seasonal change is counted as one substitution. Pool level rules are negative fractions.
	24-25R	Number of changes of coefficient "B" for all reservoirs.
	29-30R	Number of changes of coefficients "C" for all reservoirs.
	34-35R	Number of test points and junction points for which candidate dams for augmentation are to be changed.
	39-40R	Number of seasonal explicit (transbasin) diversions to be changed.
	44-45R	Number of test and junction points that are to receive conditional diversions for a different dam.
	49-50R	Number of waste volume means to be changed. A complete seasonal change at the j^{th} waste site is counted as one change.
	.....	
48-B	4-5R	Number of waste volume standard deviations to be changed.
	9-10R	Number of mean pollutant weights to be changed.

	14-15R	Number of pollutant weight standard deviations to be changed. (A complete seasonal change for the ith pollutant at the j^{th} waste site is counted as one change).
	19-20R	Number of mean low flow requirements to be changed. (A complete seasonal change at the j^{th} test site is counted as one change).
	24-25R	Number of flow requirement standard deviations to be changed.
	29-30R	Number of water quality target changes. (A complete seasonal vector change for the i^{th} pollutant at the jth test site is counted as one substitution.
		<u>Data Cards</u> <u>Conservative</u> pollutant background.
		Option A: $L \geq C = dQ^f \leq T$
		Option B: $C = d + fC + S.E.E. *t \quad t - (0,1)N$
	34-35R	Number of constant "d" changes. (Option 1 or 2).
	39-40R	Number of exponent "f" changes. (Option 1 or 2).
	44-45R	Number of maximum value "T" changes. (Option 1 only).
		Number of "S.E.E." changes. (Option 2 only).
	49-50R	Number of minimum value "L" changes. (Option 1 only).
*49-A		<u>Dam capacity changes</u>. (Refer to *48-A)
	4-5R	Dam number (not coordinate).
	6-15R.	Dam capacity.
	.....	
		Repeat for as many changes indicated by 48-A-5
		<u>Dead storage changes</u>. (Refer to *48-A)
	4-5R	Dam number (not coordinate).
	6-15R.	Dead storage.
	......	Repeat for as many changes indicated by *48-A-10.

Initial storage changes. (Refer to *48-A)

4-5R	Dam number (not coordinate).
5-15R.	Initial storage.
.....	
	Repeat for as many changes indicated by 48-A-15.

Reservoir rule curve coefficient changes. Refer to to *48-A)

4-5R	Dam number
9-10R	Season number (If entire vector is to be replaced, punch number of seasons + 1. Then skip 11-20R.).
11-20R.	Constant "A . Pool level rules are negative fractions.
.....	
	If change desired for all seasons, two cards may be necessary.
1-10R.	Constant "A", season 1.
11-20R.	Constant A", season 2.
.....	.....
51-60R.	Constant "A", Season 6.
.....	
1-10R.	Constant "A", Season 7.
.....	.....
.....	Constant "A", last season.
	Cycle for as many changes indicated by *48-A-20.
4-5R	Dam number
9-10R	Season number (If entire vector is to be replaced punch number of seasons + 1. Then skip 11-20R.

11-20R.	Regression coefficient "B".
	If change desired for all seasons, two cards may be necessary.
.....	
1-10R.	Coefficient "B", season 1.
.....	.....
51-60R.	Coefficient "B", season 6.
.....	
1-10R.	Coefficient "B" season 7.
.....	Coefficient "B", last season.
	Cycle for as many changes indicated by *48-A-25.
4-5R	Dam number.
9-10R	Season number.
11-20R.	Regression coefficient "C", skip if changing entire vector.
.....	If replacing entire seasonal vector, two cards may be necessary.
1-10R.	Regression coefficient "C", season 1.
.....	.....
51-60R.	Regression coefficient "C", season 6.
.....	
1-10R.	Regression coefficient "C",season 7.
.....	Regression coefficient "C", last season.
	Cycle for as many changes indicated by *48-A-30.

<u>Pre-specified reservoirs</u> (refer to 48-A)

4-5R	Test point or junction point number (not coordinate).
9-10R	Number of first tier (≤ 10) dams serving this point.
.....	
4-5R	Location of 1st dam serving this point.
9-10R	Location of 2nd dam serving this point.
.....	.....
	Repeat for as many changes indicated by *48-A-35

<u>Explicit diversion changes</u>. (Refer to #48-A)

4-5R	Dam number
9-10R	Location of test site that dam is to make diversions to.
11-15R	Season number (If replacing entire vector, skip 16-25R.).
16-25R.	Seasonal diversion.
	If replacing the entire vector, two cards may be necessary.
.....	
1-10R.	Diversion, season 1.
11-20R.	Diversion, season 2.
.....	.....
51-60R.	Diversion, season 6.
.....	
1-10R.	Diversion, season 7.
.....	.....
.....	Diversion, last season.
	Cycle for as many changes indicated by *45-A-40.

		Conditional diversion changes. (refer to *48-A).
	4-5R	Dam number.
	9-10R	Location of test site receiving supplementation as needed.
		Repeat for as many times as indicated in *48-A-45.
		Pollutant volume and weight changes!
		Mean waste volume changes.(refer to *48-A)
	4-5R	Waste site (not coordinate).
	9-10R	Season number. (If entire seasonal vector is to be replaced, punch number of season +1. Then skip 11-20R.)
	11-20R.	Mean waste volume change.
	.....	
		If change desired for all seasons, then two cards may be required.
	1-10R.	Mean waste volume, season 1.
	.....	.....
	51-60R.	Mean waste volume, season 6.
	.....	
	1-10R.	Mean waste volume, season 7.
	.....	.....
	.....	Mean waste volume, last season.
		Repeast for as many changes indicated by *48-A-50.
		Waste volume standard deviation changes.
*49-B	4-5R	Waste site (not coordinate).

9-10R	Season number. (If entire vector is to be replaced, punch number of seasons +1. Then skip 11-20R).
11-20R.	Standard deviation waste volume change.
.....	
	If change desired for all seasons, then two cards may be necessary.
1-10R.	Standard deviation waste volume, season 1.
.....	.....
51-60R.	Standard deviation waste volume, season 6.
.....	
1-10R.	Standard deviation waste volume, season 7.
.....	.....
.....	Standard deviation waste volume, last season.
	Cycle for as many changes indicated by *48-B-5.
	Mean waste weight changes. (Refer to *48-B)
4-5R	Waste site (not coordinate).
9-10R	Season number. (If the entire vector is to be replaced, punch number of seasons +1. Then skip if 16-25R..
15	Pollutant number.
16-25R.	Mean waste weight change.
.....	
	If change desired for all seasons, then two cards may be required.
1-10R.	Mean waste weight, season 1.
.....	.....
51-60R.	Mean waste w[illegible], season 6.
.....	

1-10R.	Mean waste weight, season 7.
.....	.....
.....	Mean waste weight, last season.
	Cycle for as many changes indicated by *48-B-10.
	Waste weight standard deviation changes.
4-5R	Waste site (not coordinate).
9-10R	Season number. (If entire vector is to be replaced, punch number of seasons +1. Then skip 16-25R.).
16-25R.	Standard deviation waste weight.
	If change desired for all seasons, two cards may be necessary.
.....	
1-10R.	Standard deviation waste weight, season 1.
11-20R.	Standard deviation waste weight, season 2.
.....	.....
51-60R.	Standard deviation waste weight, season 6.
.....	
1-10R.	Standard deviation waste weight, season 7.
.....	.....
.....	Standard deviation waste weight, last season.
	Cycle for as many changes indicated by *48-B-15.
	<u>Mean flow requirement changes.</u>(Refer to *48-B)
4-5R	Test point or junction point (not coordinate).
9-10R	Season number. (If all seasons are to be changed then punch number of seasons +1). Skip next field.)
11-20R.	Mean target flow.
.....	

	If change desired for all seasons, two cards may be necessary.
1-10R.	Mean target flow, season 1.
.....	.....
51-60R.	Mean target flow, season 6.
.....	
1-10R.	Mean target flow, season 7.
.....	.....
.....	Mean target flow, last season.
	Cycle for as many changes indicated by *48-B-20.
	Flow requirement standard deviation changes. (Refer to *48-B)
4-5R.	Test point or junction point (not coordinate).
9-10R	Season number. (If all seasons are to be changed, then punch number of seasons +1. Skip next field.)
11-20R.	Standard deviation of flow target.
.....	
	If change desired for all seasons, two cards may be necessary.
1-10R.	Standard deviation flow target, season 1.
.....	.....
51-60R.	Standard deviation flow target, season 6.
.....	
1-10R.	Standard deviation flow target, season 7.
.....	.....
.....	Standard deviation from flow target, last season.
	Cycle for as many changes indicated by *48-B-25.

	Water quality requirement changes. (Refer to *48-B)
4-5R	Test point or junction point (not coordinate).
9-10R	Pollutant number.
14-15R	Season number. (If entire seasonal vector is to be replaced, punch number of seasons +1. Skip next field).
16-25R.	Value of target concentration to be changed.
.....	.....
	If change desired for all seasons, then two cards may be necessary.
1-10R.	Target concentration, season 1.
11-20R.	Target concentration, season 2.
.....	.....
51-60R.	Target concentration, season 6.
.....	
1-10R.	Target concentration, season
.....	.....
.....	Target concentration, last season.
	Cycle for as many changes indicated by *48-B-30.
	Conservative pollutant background changes

Option 1.

	Constant in the exponential regression equation. (Refer to *48-B)
4-5R	Coordinate
9-10R	Pollutant number.
11-20R.	Constant "d" change.
.....	
	Cycle for as many changes as indicated by *48-B-35.

	Regression coefficient.
4-5R	Coordinate
9-10R	Pollutant number.
11-20R.	Exponent "f".
.....	
	Cycle for as many changes as indicated by *48-B40.
	High concentration constraint changes.
4-5R	Coordinate.
9-10R	Pollutant number.
11-29R	Constraint "T".
.....	
	Cycle for as many changes indicated by *48-B-45
	Lower concentration constraint changes.
4-5R	Coordinate.
9-10R	Pollutant number.
11-20R.	Constraint "L".
.....	
	Cycle for as many changes indicated by *48-B-50.

Option 2

	Constant in the linear regression equation
4-5R	Coordinate
9-10R	Pollutant number (limited to one)
11-20R.	Constant "d" change.
.....	
	Cycle for as many changes indicated by *48-B-35.
	Regression Coefficient
4-5R	Coordinate
9-10R	Pollutant number (limited to one)
11-20R.	Regression coefficient "f"
.....	
	Cycle for as many changes as indicated by *48-B-40.
	Standard Error of Estimate
4-5R	Coordinate
9-10R	Pollutant number (limited to one)
11-20R.	Standard Error of Estimate
.....	
	Cycle for as many changes as indicated by *48-B-45.

GENERAL NOTES CONCERNING USAGE OF OPTION D

1. The dam site and the use point should be proximate to the gaging station; however, if the basin is very homogeneous with respect to rainfall, evaporation, and morphology, then this restriction can be relaxed.

2. The gaging station need not be downstream or even on the same mainstem or tributary as the dam site and/or the use point. All three may be located on three different tributaries or mainstems.

3. The flow at the gaging station should be arrayed so that the low flow seasons are in the middle of the year while the high flow seasons begin and end the year. This facilitates computing annual supplemental storage requirements.

4. All units of flows, storage and requirements <u>must</u> be made compatible, external to the program.

5. Perform a routing using a reservoir with capacity equal to zero before selecting a number of trial reservoir sizes to meet some objective. The annual supplemental requirements will serve as a guide in reducing the number of trial reservoirs. Furthermore, if the success probability is very high using zero reservoir size, say 96%, then the necessary amount of storage to insure higher degrees of protection can be computed directly from the distributions of annual supplemental flows. Thus there would be no need for further routing analysis.

6. For eastern streams where the required storage may be between 0.1 - 0.5 of the annual flow at the reservoir site and where the record is abundant, the storage in the reservoir should be started at 90% full. For studies in which carry over storage is anticipated, the sensitivity of the starting storage should be parametrically considered.

7. If the average of the flow requirements is equal to or greater than the mean flow at the test site, then expect at least 50% failures using <u>any</u> trial reservoir size.

8. If a reservoir is to provide a high degree of protection or a high return period (98% - 1/50 failure) then caution should be exercised in selecting the proper length of record for routing. The length of record should be <u>greater</u> than the desired return period.

9. To test the hydrologic sensitivity of a design where the objective is to find the amount of storage to meet flow requirements for a given protection level, employ the following strategy:

a) Using the historical record and trial reservoir sizes, perform routings to find the required storage. Call this the central design.

b) Select a size different from the central design value. Perform at least twenty routings using different operational (synthetic) traces for the same reservoir size and dilution requirements.

c) Tabulate and plot percentage of failure vs storage for each routing.

d) Select another size and perform at least twenty routings using the same set of operational traces. Repeat c.

e) At the desired protection level, pick off the twenty storages and compute mean and standard deviation.

f) Realistic probability statements can now be made concerning safety factors or additonal storage to be added to the central design.

GENERAL NOTES CONCERNING THE USAGE OF OPTION NMP

The grand strategy of gaging station selection is to capture the pertinent hydrologic characteristics of the basin using the minimal number of gages. No clear-cut rules can be given; however, the following guides may prove helpful:

1. The gages should define as much of the area as possible. Studies to date indicate that between 20% to 60% of the area is sufficient.

2. The gages should have concurrent record lengths of at least 20 years. A sufficient number of wet and arid periods should be included.

3. They should adequately represent the regional differences; that is, the sub-basins exhibiting different types or degree of runoff should be included.

4. Gages that are proximate to important locations (new reservoirs or control points) should be included. Error is introduced whenever information (flows at gaging station) is translated or scaled to define the inflows at other points. Considerable error may be introduced when defining the inflows at a reservoir located in a headwater reach from a downstream gage whose variability and correlative structure is different.

5. Gages that have been altered by man-made activities are not desirable. Gages that are downstream of existing reservoirs that have detention times of greater than 0.1 of a year should be avoided. If it is necessary to include the gage, records can be back-routed to natural conditions: A hydrologist should be consulted if this problem arises.

6. The inclusion of many mainstem gages should be avoided because the information contained in the record of the upstream gages is also contained in the downstream gages. This is redundant information. Side gages should be used; each generally represents new or fresh information. However, the shape of the basin and length of concurrent records will usually limit this consideration.

7. This option can also be used to simulate together with stream flows, traces of conservative pollutants such as total dissolved solids, sulfates, and chlorides. In general, mainstem water quality gages downstream should be avoided. The implications of the other guidelines are also applicable.

GENERAL NOTES CONCERNING THE USAGE OF OPTION B

1. A map defining the system and all its components should be drawn and should be referred to at all times. This map should also delineate the different areas of hydrologic and water quality characteristics. This will prove most useful when modeling and verifying the natural system.

2. The system configuration should be kept as simple and as small as possible. In fact, if it is possible, complex problems should be subdivided into smaller segments. Over the course of an effort, a considerable number of man-days will be saved that would otherwise be spent purging errors from input decks for complex systems. Given that the basic data such as drainage area ratios, target flows, waste loadings, reservoir operating rules and capacities and so on have been compiled, and that familiarity with the option already exists, new input decks can be re-constituted in a very short period of time.

3. It is most desirable to have a well-developed plan of attack for sorting through various alternative designs. This is not always possible because the results are sometimes not predictable; but experience has shown that a systematic and orderly mode of attack will save time and money.

Building the hydrologic model

4. The overall strategy is twofold: First, the natural regime is approximated by defining the pertinent characteristics at each of the discrete points or locations in the system. Second, all significant existing regulation is then superimposed upon it. Every attempt should be made to separate the effects of man.

In modeling the natural system, several factors should be considered. First of all, the geomorphology of the basin should be carefully studied and differences noted. For example, runoff from an area dotted with many small lakes is apt to have less variability and have a stronger temporal correlative structure than runoff from terrain of little relief. Secondly, weather patterns and elevation differences are also important and should be noted. Yields from different portions of a seemingly homogeneous area can vary significantly. This information is useful in defining the runoff from ungaged areas by using data from other portions of the basin.

A suggested technique for quickly determining a suitable blend of gages is the following: 1) Compute grand means of upstream and side gages; 2) Compute yield for ungaged areas using combinations of the gaged means. Here, the weighting factors can be computed by drainage area ratios or, if side information is available such as a few years of gaged data, then ratios of mean flows can be used; 3) Proceed downstream and compare summation of upstream means with the mainstem mean; 4) Recycle and adjust for seasonal means and variance.

If existing reservoirs alter the nature of the inflows to them, then the reservoirs and their mode of operation must be superimposed on the natural regime. Reservoirs that have a detention time of 0.1 year or less can generally be eliminated. A convenient way to determine whether an existing reservoir changes the distribution of inflows is to plot the observed releases as a function of the sum of the observed inflows and beginning of season storage volumes. If the line of best fit departs significantly from the 45 degree equivalence line, then the reservoir must be included in the analysis. The coefficients (seasonal) that define the line(s) of best fit can then be inputed to the program as data. A horizontal line implies that the rule is to always maintain a certain flow requirement. A line having slope equal to one and displaced from the origin implies a pool elevation rule. The coefficient for this method of operation is computed by dividing the horizontal distance (quantity) between the equivalence line and the line of best fit by the capacity of the reservoir.

Existing diversions that are returned to the system during different portions of the year may be approximated by linking a test site with a waste site. Irrigation return flows and industrial and municipal wastes that are detained in lagoons may be treated in this fashion. The diversions and their return flows may be at different locations in the basin.

5. Drainage area scaling factors. Inflows to coordinates that are not at gaging stations may be scaled by a set of linear factors. These can be computed by the ratio of drainage areas or by the ratio of mean flows. It should be kept in mind that these coefficients are fixed for the entire year and have no random fluctuations added. The geomorphology and rainfall patterns are important in this respect and should be carefully considered. Furthermore, as the length of the timeframe decreases the coefficients of variation for these factors will generally increase. Thus, considerable error might be introduced into the scaled flows. Therefore, one must decide beforehand which seasons or periods of time are crucial in the analysis and adjust for them accordingly.

6. Verifying the Model. For verifying the model the following procedure is suggested:

1) Downstream gaging stations should be included as test sites in the model.

2) A concurrent period of record for both upstream and downstream gaging stations must be selected. If existing reservoirs and their mode of operation have to be considered, then the period of record should start when the reservoirs were first operated.

3) Using upstream data, route the period of record down through the system to produce data at the test sites.

4) The seasonal statistics of the measured or observed data at downstream gaging stations should be compared with the statistics of the downstream data produced by the model. The closeness of fit characterizes the validity of the model. The difference between the seasonal means should

be quite small. Often the seasonal standard deviations produced by the model are less than the observed values. This usually occurs when a substantial amount of the drainage area is not gaged and the runoff has been defined or computed from other gages.

7. Length of timeframe. It has been previously stated that the routing of flows for the entire basin is accomplished during each timeframe. During each time interval the channel flow in a upstream reach is completely combined with the intervening local flows in the next downstream reach. Bank storage or time-lagging effects are not considered. For monthly timeframes there is no need to consider these effects. For small timeframes, say weekly or less, a routing technique to correctly position the flows in time is needed. The program utilizes the modified Gilcrist flood routing technique to accommodate varying times of travel and hydraulic characteristics. At present, there is no data input for this feature. The program is coded to set the coefficients equal to unity. Coefficients equal to unity imply complete translation of flows from one reach to the next during the same time period. This feature can be generalized by removing these statements from the program and by inputing the necessary coefficients. However, the number of timeframes that can be considered is twelve. This limitation is binding because of the way the program tallies deficiencies, flows, storage levels, and pollutant concentrations. Thus the program could consider, for example, a three day routing period where each time interval is equal to three hours.

8. Waste sites. The import of water from another basin may be represented by a waste site.

9. Test sites. A test site may be specified to receive explicit and conditional pipeline withdrawals from the same reservoir. Furthermore, the same test site may be specified to call for further augmentation by channel releases from up to ten upstream reservoirs. To divert water from a stream where there is no reservoir (pump-pipeline), place a reservoir having unit capacity at that location. This is limited to explicit pipeline diversions.

10. Reservoirs. Reservoirs in series cannot be effectively treated by this program. If the purpose of a study is to consider the storage requirements for satisfying only instream flow requirements, then second and third tier reservoirs may be specified to make conditional pipeline diversions down to the test site. The reservoir on the highest tier is first depleted. If a demand still exists at the test site, releases are then made from the reservoir on the next tier.

11. Additional notes for card input - Option B.

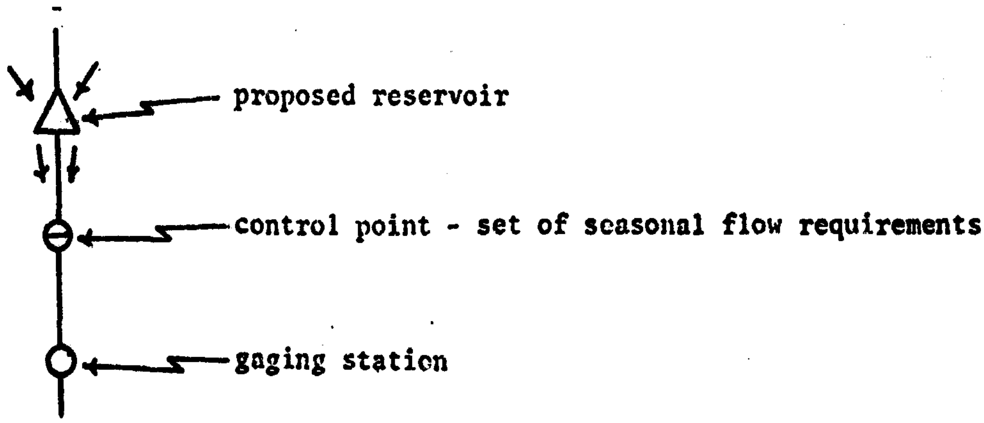
1. Card [illegible] If this program is used at an installation where magnetic tapes are used for storing intermediate results (scratch devices), then the number of runs should be limited to eight. This constraint is necessary because the intermediate system response output for eight runs generally fills a reel of tape. This limitation is not as binding if scratch disk devices can be used.

2. Card 8-15 Often it is desirable to have the historical flows on binary tape when the historical trace is used to test alternative plans. This saves the duplication of decks of historical flows. A binary tape containing historical flows can be used; however, this tape must be prepared external to this option.

3. Card 8-20 This option is used to position the binary flow tape at the beginning of each run. It may be used to test the hydrologic sensitivity of a plan by using different traces of operational hydrology. Furthermore, the same trace can ge positioned to test different plans.

Output for Option D

Sample Problem



Given: 1) Seasonal coefficients for translating flows at gaging station to inflows at dam site starting with the month of April: 0.292, 0.301, 0.235, 0.214, 0.279, 0.256, 0.299, 0.340, 0.339, 0.305, 0.272, 0.281;

2) Seasonal coefficients for calculating the unregulated inflows (between dam site and use point) from the inflows at the dam site: 1.902, 1.835, 2.622, 2.995, 2.055, 1.855, 1.511, 1.539, 1.812, 2.135, 2.042;

3) 60 years of historical flows at the gaging station;

4) Twelve seasonal flow requirements of 760 cfs-mo. at the use point;

5) A reservoir whose volume is equal to 100 cfs-mo. and whose starting contents are assumed full at the start of the routing period; and that;

6) The mode of reservoir operation is to always meet downstream flow requirments.

Find: The statistical characteristics of deficiencies at the test site and the seasonal probability distributions of storage levels in reservoir.

Option D Output

Page 1 Data input echo

a) Seasonal flows at the dam site.

b) Seasonal coefficients for translating flows at the gaging station to inflows at the dam site.

c) Seasonal coefficients used to calculate the unregulated inflows (between the dam site and use point) from the inflows at dam site.

d) If reservoir operating modes 2 or 3 have been specified, then the coefficients for the set of regression equations for computing seasonal releases will appear.

Page 2 Statistics of historical flows at dam site.

a) Seasonal means, standard deviations, skewness coefficients, lag one correlation coefficients, and the coefficients of variation.

b) Grand seasonal mean, standard deviation, lag one correlation coefficient, and coefficient of variation.

c) Annual mean, standard deviation, skewness, lag one correlation coefficient, and coefficient of variation.

d) Seasonal histograms of flows.

e) Histograms for all seasons.

f) Histograms of annual flows.

The output for the histogram analysis is intrepreted in the folllowing manner: Consider October: 1) 7/60 or 11.6% of all Octobers the flow is equal or less than 50.28 cfs; 2) 15/60 or 25% of all Octobers the flow is equal to or less than 75.42 cfs; and 3) 48/60 or 60% of Octobers the flow is equal to or less than 502.8 cfs.

TITLE OF STUDY TIOGA HAMMOND COWANESQUE RESERVOIRS ELMIRA USE CENTER

YEAR	HISTORICAL RECORD			SEASONS								
1900	1940.	1487.	724.	175.	129.	68.	196.	118.	255.	714.	674.	717.
1901	958.	219.	696.	223.	174.	100.	147.	197.	983.	701.	544.	1931.
1902	1764.	807.	653.	194.	272.	52.	335.	666.	709.	1525.	264.	1166.
1903	1107.	707.	258.	193.	45.	55.	253.	785.	1593.	732.	975.	2894.
1904	1118.	1812.	251.	164.	93.	29.	58.	66.	46.	695.	1444.	871.
1905	1553.	1857.	597.	59.	36.	34.	48.	53.	66.	689.	408.	2979.
1906	1880.	1276.	282.	62.	37.	52.	45.	99.	152.	991.	378.	969.
1907	1346.	285.	170.	28.	62.	130.	404.	322.	719.	213.	408.	2290.
1908	2608.	1153.	165.	58.	80.	563.	389.	571.	739.	2232.	294.	2186.
1909	1434.	768.	196.	68.	40.	37.	335.	915.	294.	714.	674.	717.
1910	3066.	2453.	175.	91.	285.	170.	71.	139.	146.	1583.	2747.	762.
1911	1028.	479.	193.	1136.	1247.	223.	676.	452.	437.	1354.	373.	1933.
1912	4146.	1158.	2197.	218.	92.	94.	166.	186.	165.	253.	244.	1323.
1913	949.	837.	1349.	869.	965.	456.	1683.	666.	304.	168.	1491.	2669.
1914	1571.	777.	381.	81.	78.	238.	505.	636.	553.	522.	213.	1943.
1915	1419.	3461.	355.	198.	215.	191.	131.	728.	373.	83.	105.	2802.
1916	788.	497.	124.	338.	326.	135.	261.	585.	993.	314.	593.	1857.
1917	803.	497.	92.	95.	86.	99.	94.	1346.	715.	348.	903.	1807.
1918	1691.	406.	1166.	366.	293.	187.	110.	95.	133.	351.	294.	2200.
1919	917.	641.	133.	57.	43.	38.	74.	110.	641.	1138.	245.	1085.
1920	2584.	1893.	296.	186.	90.	231.	583.	95.	172.	75.	2162.	1029.
1921	724.	722.	133.	143.	127.	109.	358.	1023.	739.	555.	517.	1967.
1922	1606.	247.	146.	53.	225.	208.	460.	1897.	323.	759.	1281.	2549.
1923	1019.	1827.	277.	88.	130.	53.	736.	3104.	2955.	491.	786.	1453.
1924	1916.	1261.	1079.	411.	335.	76.	83.	234.	435.	381.	458.	2546.
1925	3050.	1815.	249.	139.	69.	53.	475.	646.	688.	1430.	707.	2091.
1926	1101.	620.	451.	146.	46.	36.	37.	39.	62.	63.	157.	1087.
1927	1515.	1544.	430.	235.	166.	98.	48.	79.	542.	1153.	889.	891.
1928	2246.	1592.	127.	68.	41.	25.	152.	1006.	270.	292.	158.	1574.
1929	1714.	945.	247.	151.	689.	353.	147.	323.	544.	823.	89.	1141.
1930	1539.	199.	90.	34.	66.	189.	118.	373.	446.	895.	353.	1679.
1931	1765.	1057.	175.	1259.	367.	129.	180.	634.	647.	277.	276.	5876.
1932	1544.	474.	147.	43.	169.	72.	143.	738.	555.	2346.	458.	685.
1933	2478.	1338.	491.	117.	779.	254.	634.	1397.	889.	650.	1059.	1563.
1934	1255.	553.	267.	102.	76.	376.	123.	234.	557.	368.	1932.	1921.
1935	1231.	282.	83.	44.	75.	29.	111.	242.	475.	170.	197.	1418.
1936	5609.	1029.	536.	247.	111.	142.	100.	265.	1978.	434.	206.	942.
1937	2378.	249.	149.	56.	54.	26.	31.	63.	254.	184.	227.	2928.
1938	1245.	858.	248.	245.	444.	218.	604.	1216.	1866.	1123.	1001.	1537.
1939	1761.	3022.	348.	97.	91.	49.	360.	967.	239.	144.	380.	1301.
1940	1594.	1530.	583.	135.	56.	40.	77.	124.	328.	303.	997.	3763.
1941	919.	2465.	552.	189.	137.	392.	851.	1375.	1515.	1499.	224.	1448.
1942	270.	2510.	1139.	357.	617.	204.	575.	342.	256.	1135.	499.	875.
1943	2630.	2342.	1077.	423.	554.	347.	115.	291.	323.	151.	899.	3025.
1944	2044.	1315.	394.	171.	220.	55.	86.	471.	575.	1351.	815.	758.
1945	1096.	593.	117.	42.	69.	67.	64.	128.	418.	1019.	432.	2385.
1946	2097.	973.	309.	100.	197.	296.	773.	2141.	2152.	1466.	1670.	2291.
1947	1906.	369.	352.	360.	85.	59.	53.	335.	1006.	2015.	977.	2157.
1948	1918.	1332.	230.	76.	76.	52.	78.	415.	1307.	974.	721.	1741.
1949	1127.	1275.	471.	113.	92.	42.	49.	136.	262.	263.	727.	1149.
[illegible]	[illegible]	1333.	444.	56.	43.	32.	53.	90.	542.	693.	466.	2523.

1954	4675.	1364.	458.	223.	112.	162.	221.	557.	340.	1247.	781.	1586.
1955	1940.	515.	109.	53.	114.	83.	660.	1354.	2293.	826.	972.	1421.
1956	2760.	2399.	1330.	147.	137.	77.	64.	92.	75.	65.	1342.	1383.
1957	3276.	1327.	632.	193.	255.	107.	78.	168.	174.	400.	227.	1706.
1958	2102.	484.	121.	36.	45.	55.	237.	515.	533.	276.	132.	2359.
1959	1000.	554.	165.	80.	52.	36.	38.	250.	525.	933.	336.	3608.

SEASONAL COEFS. FOR TRANSLATING FLOWS AT GAGING STATION TO INFLOWS AT THE DAMSITE

0.292 0.301 0.235 0.214 0.279 0.256 0.299 0.340 0.339 0.305 0.272 0.281

SEASONAL COEF. THAT SCALE THE INFLOWS AT DAMSITE TO UNREGULATED LOCAL INFLOWS AT TEST SITE

1.902 1.835 2.622 2.995 2.055 2.325 1.855 1.511 1.519 1.812 2.135 2.042

SEASONAL STATISTICS 60 YEARS

SEASON	MEAN	DEVN	SKEWNESS	CORR BACK	COEF. VAR.
APR	0.1849E 04	0.9963E 03	0.1468E 01	-0.3735E-01	0.5399E 00
MAY	0.1235E 04	0.7417E 03	0.9790E 00	0.1924E 00	0.6534E 00
JUNE	0.4152E 03	0.3862E 03	0.2290E 01	0.2855E 00	0.9302E 00
JULY	0.1731E 03	0.2324E 03	0.3102E 01	0.2529E 00	0.1704E 01
AUG	0.2000E 03	0.2360E 03	0.2496E 01	0.6829E 00	0.1180E 01
SEPT	0.1352E 03	0.1205E 03	0.1490E 01	0.4754E 00	0.8909E 00
OCT	0.3048E 03	0.4096E 03	0.3294E 01	0.3185E 00	0.1344E 01
NOV	0.5731E 03	0.5947E 03	0.1900E 01	0.5517E 00	0.1038E 01
DEC	0.6545E 03	0.5849E 03	0.1866E 01	0.6801E 00	0.8722E 00
JAN	0.7227E 03	0.5351E 03	0.8632E 00	0.2593E 00	0.7402E 00
FEB	0.6597E 03	0.5314E 03	0.1654E 01	0.1014E 00	0.7947E 00
MAR	0.1432E 04	0.9429E 03	0.1518E 01	-0.1077E 00	0.5145E 00
	0.7233E 03	0.8133E 03	0.2014E 01	0.4080E 00	0.1124E 01
	0.8680E 04	0.2315E 04	0.2708E 00	-0.1121E 00	0.2557E 00

STATISTICS FOR ALL SEASONS, OBSERVS. # 72[illegible]

YEARLY STATISTICS

HISTOGRAMS OF SEASONAL FLOWS FOR 60 YEARS
GRID SPACING FOR 1ST TEN COLUMNS IS 1/100TH OF MAXIMUM SEASONAL FLOW.
GRID SPACING FOR COLUMNS 11-20 IS 1/10TH OF MAXIMUM SEASONAL FLOW

PERCENTILES OF MAXIMUM SEASONAL FLOW

SEASON	1	2	3	4	5	6	7	8	9	10 *	11	12	13	14	15	16	17	18	19	20
APR	0	0	0	0	1	0	0	0	0	0 *	1	15	14	15	8	3	1	1	1	1
MAY	0	0	0	0	0	1	1	2	3	0 *	7	13	11	13	4	5	2	3	1	1
JUNE	0	0	1	1	4	4	5	5	2	0 *	22	18	11	2	3	2	1	0	0	1
JULY	0	0	4	3	8	2	3	5	3	1 *	29	22	4	2	0	0	1	0	0	2
AUG	0	0	2	7	4	4	8	4	2	1 *	32	15	6	1	2	1	1	1	0	1
SEPT	0	0	0	0	2	4	4	1	3	8 *	22	15	5	7	3	2	4	0	1	1
OCT	0	7	8	7	5	4	2	3	1	1 *	38	10	8	2	0	0	1	0	0	1
NOV	0	2	6	5	4	2	1	3	2	1 *	26	13	9	4	4	1	2	0	0	1
DEC	0	1	3	0	2	4	0	0	5	2 *	17	19	12	4	1	3	1	2	0	1
JAN	0	0	1	3	0	0	2	2	1	1 *	10	15	5	13	5	5	5	1	0	3
FEB	0	0	0	2	1	2	1	3	5	1 *	15	17	11	9	2	2	1	2	0	1
MAR	0	0	0	0	0	0	0	0	0	0 *	0	18	10	11	9	3	2	0	0	1

HISTOGRAM FOR ALL SEASONAL EVENTS

63	90	62	46	49	24	31	19	23	18 *	425	143	72	40	23	10	3	7	0	2

HISTOGRAM OF ANNUALS

0	0	0	0	0	0	0	0	0	0 *	0	0	2	2	18	9	12	7	9	1

RANGE FOR EACH SEASONAL HISTOGRAM

0.5609E 04	0.3461E 04	0.2197E 04	0.1259E 04	0.1247E 04	0.3632E 03
0.2514E 04	0.3104E 04	0.2966E 04	0.2202E 04	0.2747E 04	0.5875E 04

RANGE FOR TIME INVARIANT SEASONAL HISTOGRAM 0.5876E 04 RANGE FOR ANNUAL HISTOGRAM, 0.1455E 05

Page 3 Skewness transform diagnostics.

Three different transformations of the flow data are tried with the purpose of finding the transformation which minimizes the skewness of the data. The three transforms are: no transform, log 10, and square root. An overall skewness coefficient is determined by weighting the seasonal skewness coefficients by the means of their respective seasons. The three diagnostics that appear are the weighted coefficients for each transform divided by the standard deviation of the skewness coefficient. This standard deviation is computed from a formulation by Kendall and depends only on the sample size (5). The transform whose diagnostic is minimal is chosen to be used later in the streamflow simulation analysis.

Pages 4-11 are devoted to describing the statistical performance of the system using the historical period of record. Pages 11-19 are the exact counterparts using a trace of operational or synthetic hydrology. They will not appear nor be discussed. However, the print suppress features for the synthetic record analysis output will be indicated in the discussion of the historical record routing output.

Page 4. Statistical moments of deficiencies.

a) Shown for each season is the probability of failure, the mean of all the failures, the standard deviation, the maximum miss, and the minimum miss. These failures are tallied without regard for the duration of the miss. Section c deals with these statistics. On input card 7 for this option a non-zero punch in column 2 will suppress this output in the historical record analysis. A non-zero punch in column 14 will suppress this output in the synthetic record analysis.

b) The annual probability of failure, the mean annual failure, the standard deviation, the maximum annual failure and the minimum annual failure are then presented. An annual failure is tallied if the flow requirement for any season during that year is not maintained. The magnitude of an annual miss is the sum of all seasonal misses during that year. A non-zero punch in columns 4 and 16 will suppress this output in the historical record and in the synthetic record analysis respectively.

```
T - DIAGNOSTICS, T = SKEW/S.E.%SKEW<
NO TRANSFORM       5.306  LOG 10 TRANSFORM       1.047  SQRT TRANSFORM       2.693
MINIMUM SKEWNESS OCCURS WHEN  LOG   TRANSFORM ISUSED
```

HISTORICAL RECORD ROUTING WATER SUPPLY STORAGE YEAR 1980 COOLING WATER EXCLUDED (76 CFS)
YEARS OF ROUTING 60 SEASONS 12 DAM TRY 1 DAM SIZE 100. STARTING STORAGE 100. DILUTION SET 1

STATISTICS OF ONE-SEASON MISSES

SEASON	DIL. REQD	C.V.	PROB.	MEAN	S.D.	MAXIMUM	MINIMUM
APR	760.	0.0	0.0	0.0	0.0	0.0	0.0
MAY	760.	0.0	0.033	67.8	0.0	96.8	38.3
JUNE	760.	0.0	0.333	200.2	127.5	456.3	25.9
JULY	760.	0.0	0.617	369.9	191.2	648.9	6.0
AUG	760.	0.0	0.783	417.8	197.3	649.2	7.8
SEPT	760.	0.0	0.767	482.5	171.6	677.4	69.7
OCT	760.	0.0	0.667	438.1	187.3	672.1	13.9
NOV	760.	0.0	0.433	400.4	181.4	662.7	28.3
DEC	760.	0.0	0.250	331.9	214.3	643.0	14.4
JAN	760.	0.0	0.200	292.3	205.3	582.5	19.8
FEB	760.	0.0	0.150	196.0	152.0	431.7	14.5
MAR	760.	0.0	0.0	0.0	0.0	0.0	0.0
ANNUAL STATISTICS			1.0	1658.3	994.6	4103.0	14.4

STATISTICS OF CONSECUTIVE SEASONAL MISSES

DURATION	PROB.	MEAN	S.D.
1	0.353	385.19	200.72
2	0.246	876.01	296.13
3	0.169	1384.65	365.77
4	0.106	1894.83	438.17
5	0.059	2424.66	463.97
6	0.028	2880.15	493.92
7	0.010	3329.33	519.62
8	0.004	3737.71	322.45
9	0.001	3665.53	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.0
13	0.0	0.0	0.0
14	0.0	0.0	0.0
15	0.0	0.0	0.0
16	0.0	0.0	0.0
17	0.0	0.0	0.0
18	0.0	0.0	0.0
19	0.0	0.0	0.0
20	0.0	0.0	0.0
21	0.0	0.0	0.0
22	0.0	0.0	0.0
23	0.0	0.0	0.0
24	0.0	0.0	0.0
25	0.0	0.0	0.0
26	0.0	0.0	0.0
27	0.0	0.0	0.0
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
31	0.0	0.0	0.0
32	0.0	0.0	0.0
33	0.0	0.0	0.0
34	0.0	0.0	0.0

c) The probability of failure, the mean, and the standard deviation for failures of different durations are shown A duration of a continual failure may be as long as 36 seasons. The magnitude of a miss for any stated duration includes all prior consecutive misses. A non-zero punch in columns 6 and 18 will suppress this output in the historical and in synthetic record analysis,respectively.

Page 5 Distribution of failures.

The accumulative histograms of failures for each season and for the annual failures appear in tabular form. Consider the month of September; half of the misses were equal to 542 cfs or less. Consider the annual misses; 95% of the annual misses were equal to 3283 cfs or less. A one punched in columns 8 and 20 will suppress this output in the historical record and in the synthetic record analysis respectively.

Page 6 Distribution of storage levels.

The probability distributions of storage volumes for each season is shown in tabular form. Consider the month of June; in 33% of the Junes, the storage in the reservoir was equal to 10 cfs-mo. or less. For the month of March, the storage in the reservoir was always between 90 cfs-mo. or full. A one punched in columns 10 and 22 will suppress this output in the historical record and in the synethetic record analysis respectively.

Moments of flows past test points.

The mean and the standard deviation for the flows at the test site are shown for each season. A non-zero punch in columns 12 and 24 will suppress this output in the historical record and in the synthetic record analysis respectively.

Pages 7, 8, and 9 Accumulative histograms of seasonal and annual failures.

Presented on page 7 in graphical form are the accumulative distribution of failures for the first six months of the year used in the analysis. Here the first month is April. The remaining 6 months will be found on page 8. The ordinate scale of the plot is the accumulative probability; each tic being equal to .02 or 2 percent. On the absicca the scale is the percentage of the range or maximum miss expressed in

ACCUMULATIVE FREQUENCY DISTRIBUTIONS OF ONE - SEASON MISSES

ELEMENTS IN FIRST ROW ARE ACCUMULATIVE PROBABILITIES, ELEMENTS IN 2ND ROW ARE CORRESPONDING INTERMEDIATE RANGES

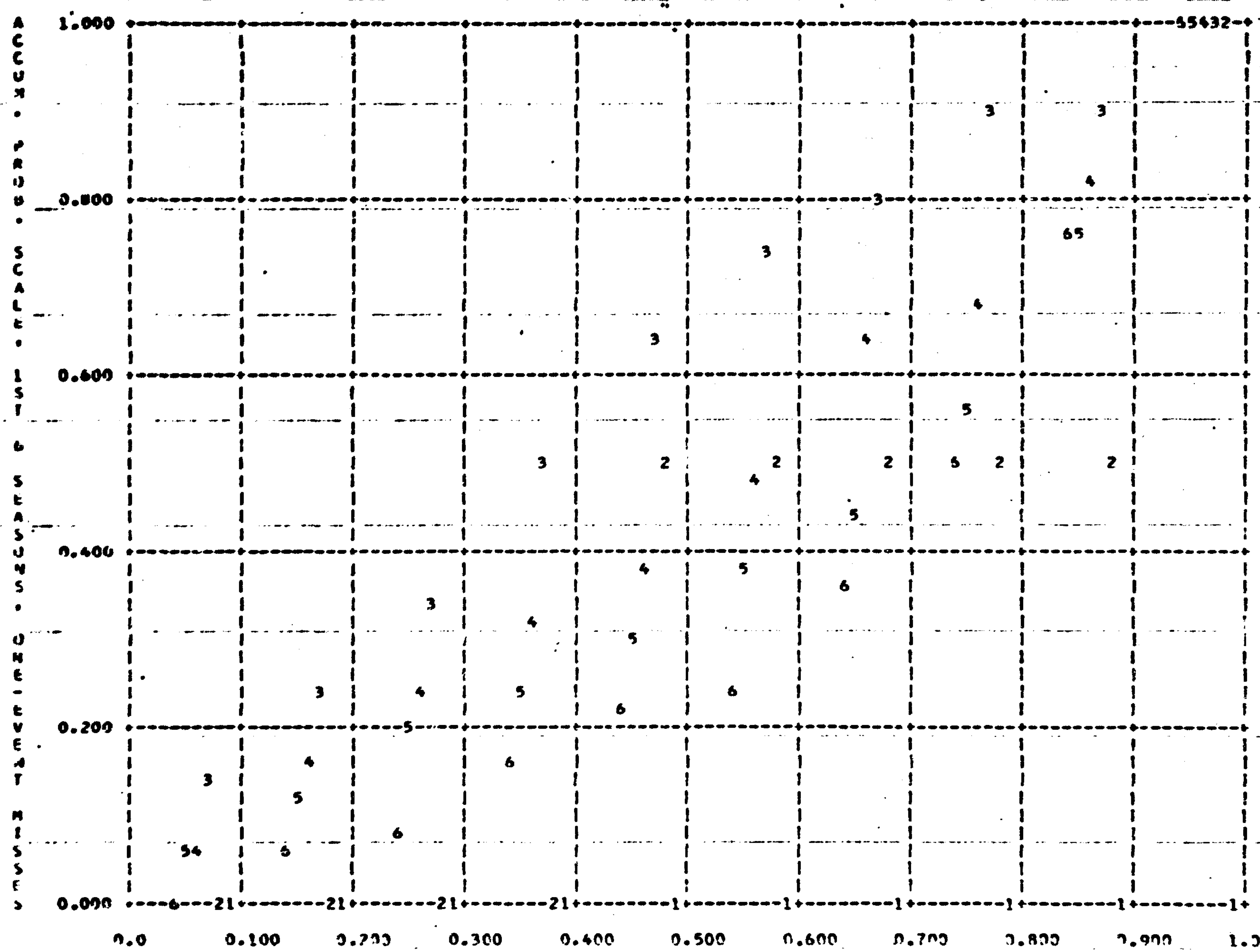
SEASON										
APR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAY	0.0	0.0	0.0	0.0	0.500	0.500	0.500	0.500	0.500	1.000
	10.	19.	29.	39.	48.	58.	68.	77.	87.	97.
JUNE	0.150	0.250	0.350	0.500	0.650	0.750	0.800	0.900	0.900	1.000
	46.	91.	137.	183.	228.	274.	319.	365.	411.	456.
JULY	0.054	0.162	0.243	0.324	0.378	0.486	0.649	0.576	0.811	1.000
	65.	130.	195.	260.	324.	389.	454.	519.	584.	649.
AUG	0.064	0.128	0.191	0.234	0.298	0.383	0.447	0.553	0.766	1.000
	65.	130.	195.	260.	325.	390.	454.	519.	584.	649.
SEPT	0.0	0.065	0.087	0.152	0.217	0.239	0.370	0.500	0.761	1.000
	68.	135.	203.	271.	339.	406.	474.	542.	610.	677.
OCT	0.050	0.100	0.150	0.200	0.300	0.375	0.450	0.600	0.750	1.000
	67.	134.	202.	269.	336.	403.	470.	538.	605.	672.
NOV	0.038	0.115	0.231	0.231	0.308	0.346	0.577	0.731	0.885	1.000
	66.	133.	199.	265.	331.	398.	464.	530.	596.	663.
DEC	0.133	0.333	0.333	0.333	0.400	0.600	0.733	0.733	0.800	1.000
	64.	129.	193.	257.	322.	386.	450.	514.	579.	643.
JAN	0.167	0.250	0.250	0.417	0.583	0.583	0.667	0.750	0.750	1.000
	58.	116.	175.	233.	291.	349.	408.	466.	524.	582.
FEB	0.222	0.333	0.333	0.333	0.556	0.667	0.778	0.778	0.889	1.000
	43.	86.	130.	173.	216.	259.	302.	345.	389.	432.
MAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DISTRIBUTION OF ANNUAL MISSES										
	0.119	0.220	0.373	0.492	0.695	0.763	0.831	0.949	0.983	1.000
	410.	821.	1231.	1641.	2052.	2462.	2872.	3282.	3693.	4103.

DAM CAPACITY 100.000 SEASONAL DISTRIBUTIONS OF STORAGE LEVELS
ELEMENTS IN EACH ROW ARE THE PROBABILITIES ASSOCIATED WITH PERCENTAGES OF CAPACITY SHOWN

SEASON	EMPTY	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.	FULL
APR		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	
MAY		0.033	0.0	0.0	0.0	0.017	0.0	0.017	0.0	0.0	0.933	
JUNE		0.333	0.0	0.017	0.0	0.0	0.017	0.0	0.0	0.0	0.633	
JULY		0.617	0.0	0.0	0.0	0.017	0.0	0.0	0.0	0.017	0.350	
AUG		0.783	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.217	
SEPT		0.783	0.017	0.0	0.017	0.0	0.0	0.017	0.0	0.017	0.150	
OCT		0.667	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.333	
NOV		0.433	0.0	0.0	0.0	0.0	0.017	0.0	0.0	0.017	0.533	
DEC		0.250	0.017	0.0	0.0	0.0	0.017	0.017	0.0	0.017	0.683	
JAN		0.200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.017	0.783	
FEB		0.183	0.0	0.0	0.0	0.017	0.017	0.0	0.0	0.0	0.783	
MAR		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	

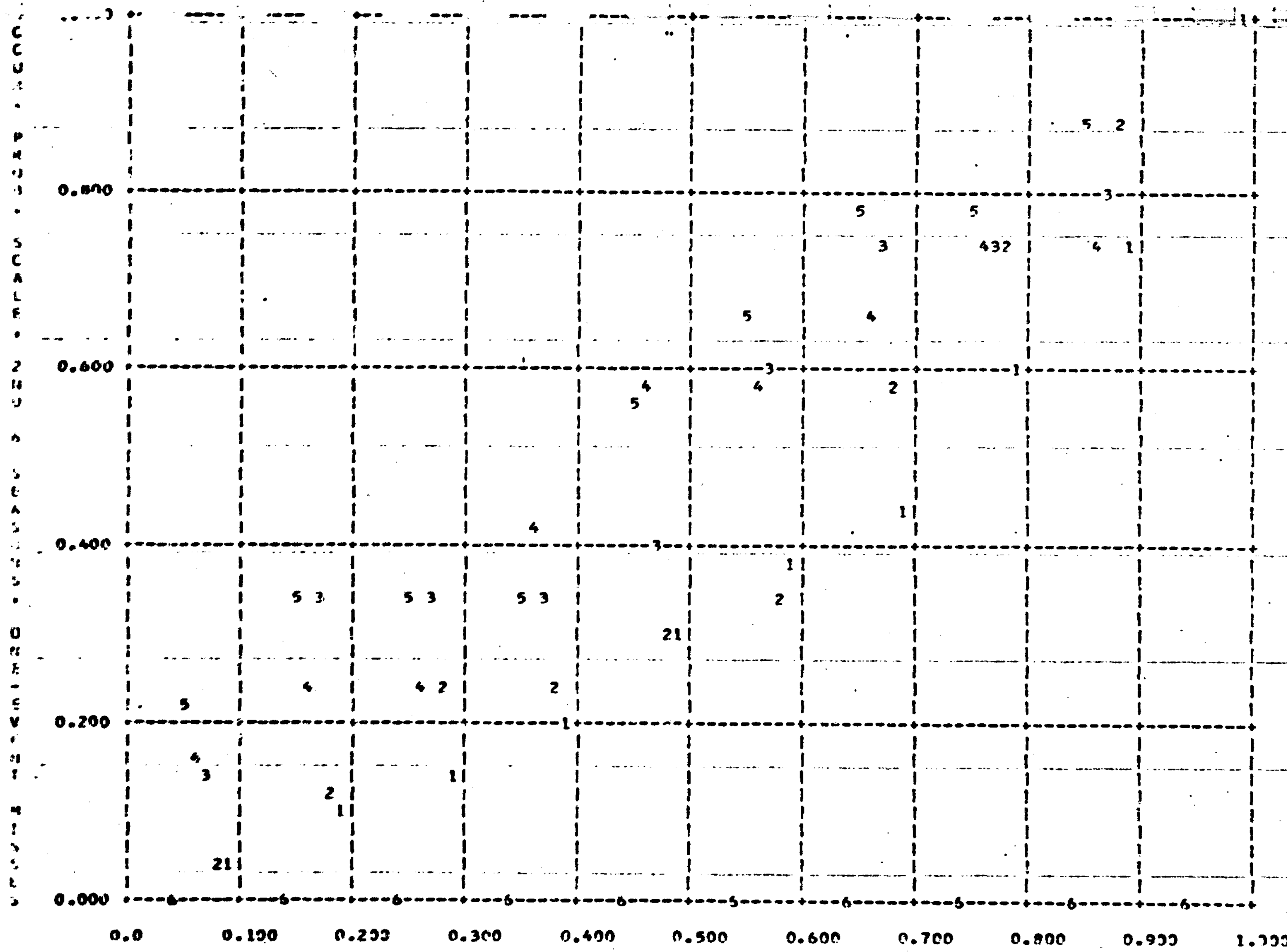
MEANS AND STD. DEVNS. OF SEASONAL FLOWS PAST TEST POINT

MEAN	5355.0	3222.4	1534.5	798.9	626.4	453.0	855.3	1416.8	1532.3	2024.7	2095.8	5554.4
S.D.	2891.3	2096.8	1374.5	902.3	708.7	384.0	1149.5	1490.0	1470.6	1495.6	1647.4	2872.3



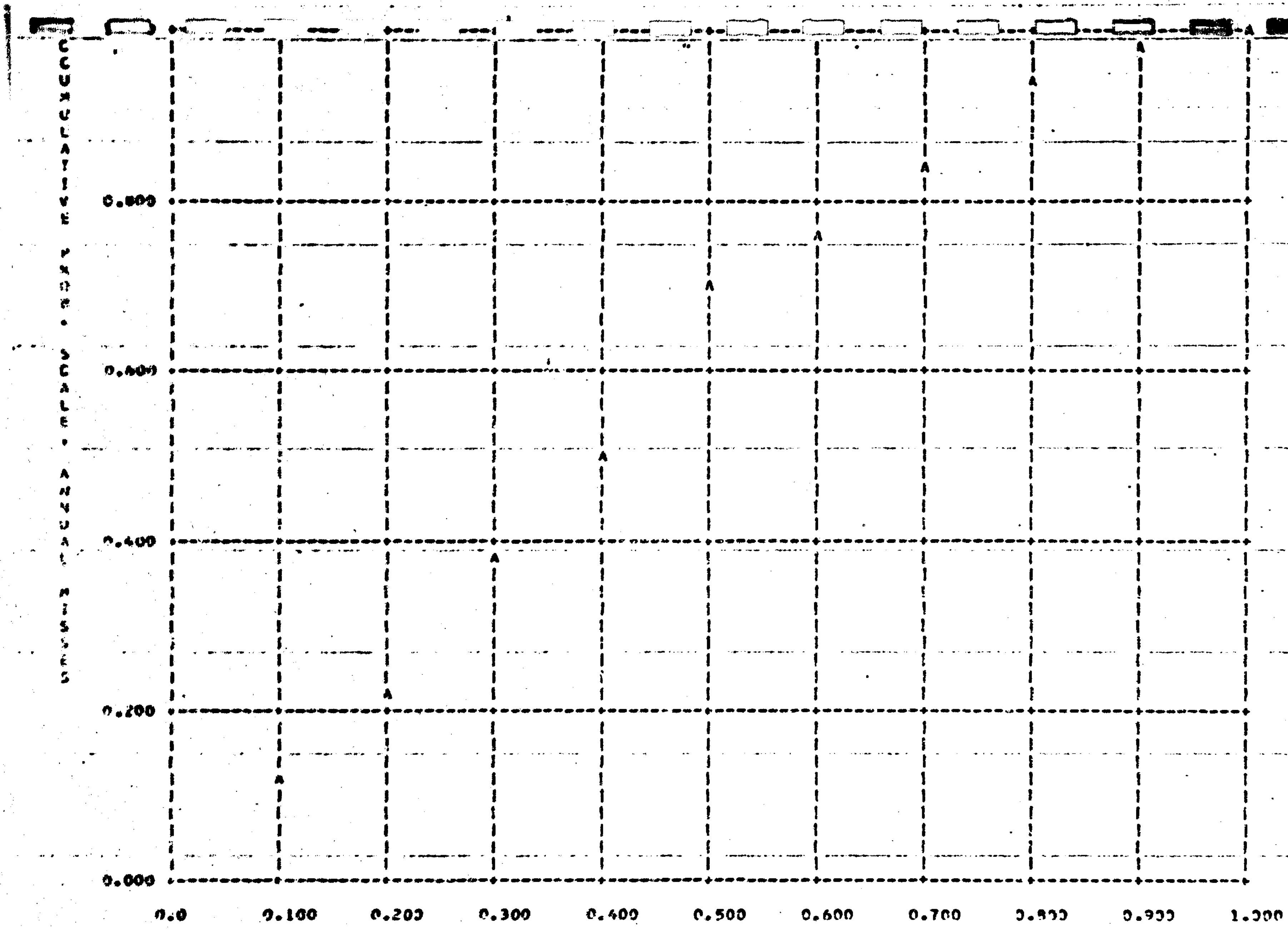
PERCENTAGE OF MAXIMUM MISS

MAXIMUM SEASONAL MISSES	0.0	97.	456.	649.	649.	577.
KEY SEASONS	1 - APR *	2 - MAY *	3 - JUNE*	4 - JULY*	5 - AUG *	6 - SEPT*



PERCENTAGE OF MAXIMUM MISS

MAXIMUM SEASONAL MISSES	672.	663.	643.	582.	432.	0.0
KEY SEASONS	1 - OCT *	2 - NOV *	3 - DEC *	4 - JAN *	5 - FEB *	6 - MAR *



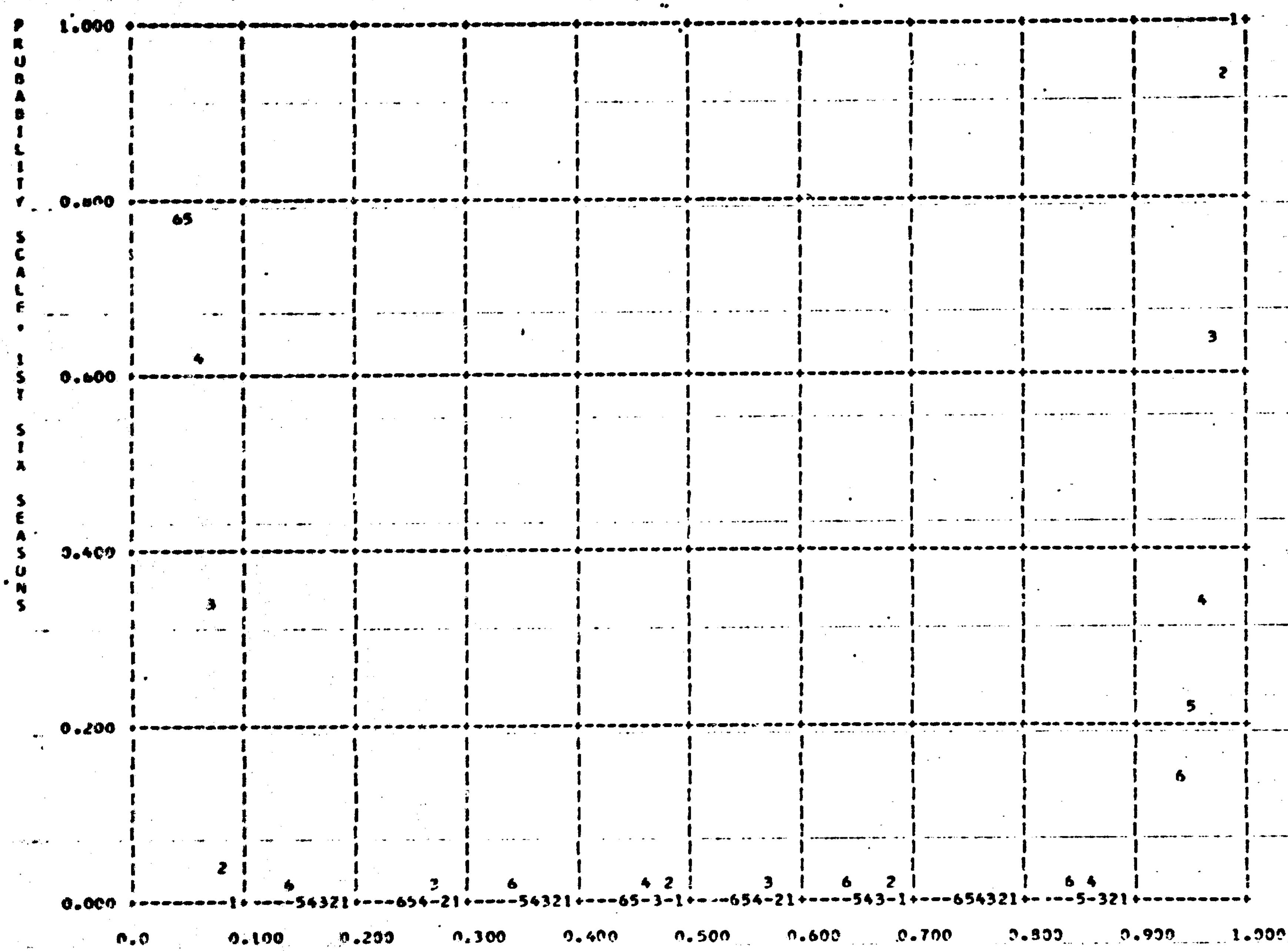
PERCENTAGE OF MAXIMUM MISS

MAXIMUM ANNUAL MISS 4103.

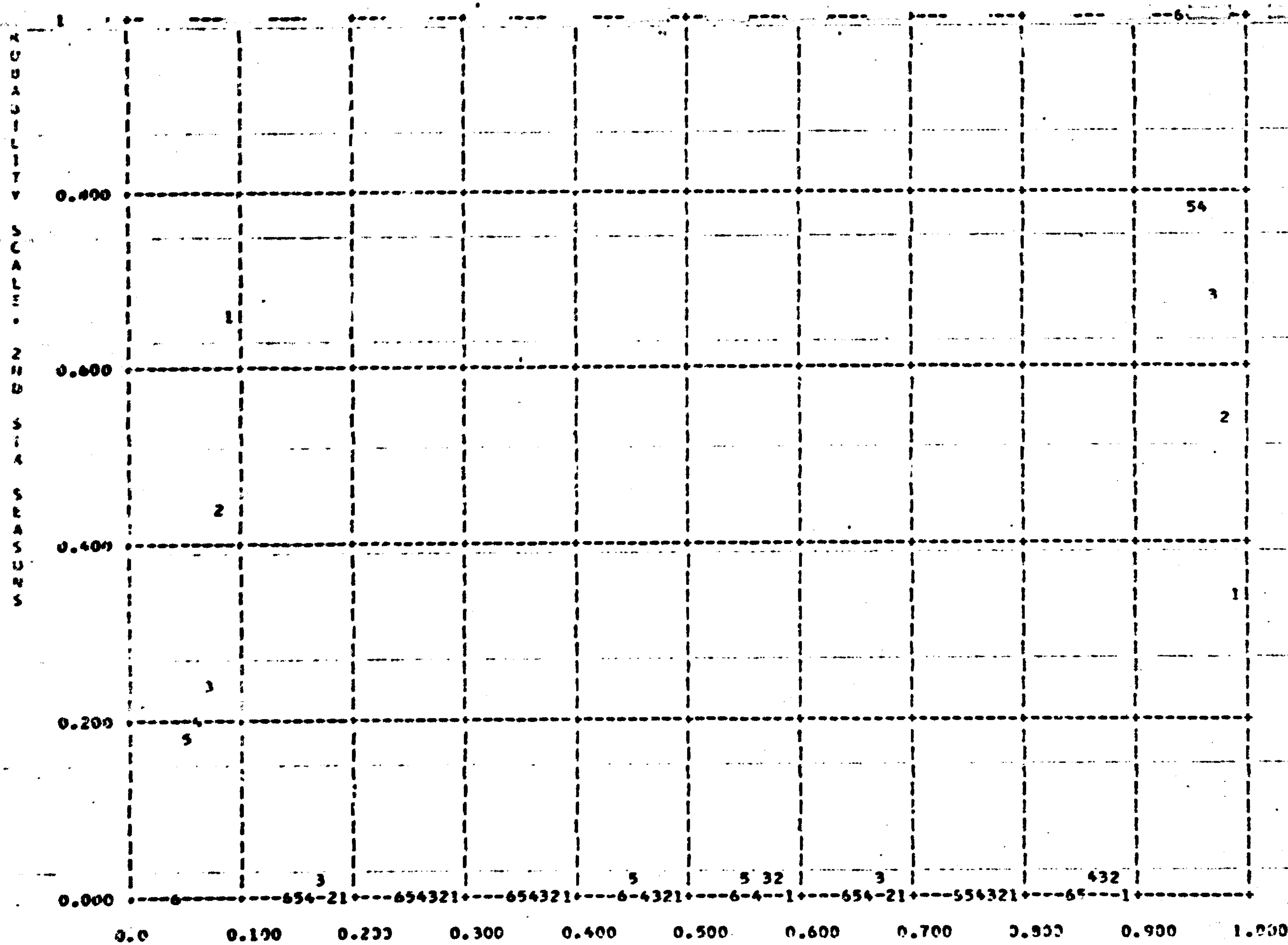
decimal form. The maximum failures for each of the six seasons are shown directly below. The numeric entries ("1" - "6") are plotted at 10 percent intervals. In each block they appear spaced from left to right ("6" - "1"), always to the left of their grid point. This constraint is necessary to preclude the possibility of overlap. Simply displace each entry to the nearest 10th point to the right and read. Consider the following examples. For the month of July and August, 6 percent of the deficiencies were equal to 65 cfs or less. For the month of June, 80 percent of the misses were equal to (.7*456.) or 319.2 cfs or less. Shown on page 9 is the accumulative histogram of annual failures. A two punched in columns 8 and 20 will suppress both the tabular and graphical displays in the historical record and in the synthetic record analysis respectively.

Pages 10 and 11 Storage level probability distributions. The distributions of storage volumes appear in graphical form for the first six months of the year on page 10. The distributions for the remaining 6 months appear on the following page. The ordinate scale of the plot is the probability of occurrence and not the accumulative probability. The absicca scales the reservoir's capacity. Consider the month of June. The storage in the reservoir was 10 cfs-mo. or less for 34 percent of the Junes. A two punched in columns 10 and 22 will suppress the tabular and the graphical displays in historical record and in the synthetic record analysis respectively.

Page 20. Statistics of generated flows. The statistical parameters for the first 100 years of the generated trace at the dam site appears on this page. If less than 100 years were specified, then the entire trace will be used to compute the parameters. This output is precisely like that presented for the historical trace on page 2. A non-zero punch in column 26 will suppress this output.



PERCENTAGE OF RESERVOIR CAPACITY CAPACITY = 100.
KEY SEASONS 1 - APR * 2 - MAY * 3 - JUNE* 4 - JULY* 5 - AUG * 6 - SEPT*



PERCENTAGE OF RESERVOIR CAPACITY   CAPACITY = 100.
KEY SEASONS   1 - OCT *   2 - NOV *   3 - DEC *   4 - JAN *   5 - FEB *   6 - MAR *

STATISTICS OF GENERATED FLOWS ,ONLY FIRST 100 YEARS OF TRACE ARE USED

SEASONAL STATISTICS 60 YEARS

SEASON	MEAN	DEVN	SKEWNESS	CORR BACK	COEF. VAR.
APR	0.2017E 04	0.1081E 04	0.5185E 00	-0.2669E 00	0.5359E 00
MAY	0.1283E 04	0.8767E 03	0.1533E 01	0.2823E 00	0.6834E 00
JUNE	0.3896E 03	0.3376E 03	0.2251E 01	0.3049E 00	0.8566E 00
JULY	0.1941E 03	0.1349E 03	0.1198E 01	0.5688E 00	0.6951E 00
AUG	0.1849E 03	0.1511E 03	0.1880E 01	0.5939E 00	0.8176E 00
SEPT	0.1244E 03	0.9787E 02	0.3834E 01	0.6428E 00	0.7869E 00
OCT	0.2869E 03	0.2856E 03	0.2285E 01	0.1375E 00	0.9953E 00
NOV	0.6529E 03	0.7800E 03	0.2728E 01	0.6778E 00	0.1195E 01
DEC	0.6571E 03	0.6558E 03	0.2546E 01	0.5869E 00	0.9981E 00
JAN	0.1069E 04	0.1216E 04	0.1873E 01	0.3861E 00	0.1138E 01
FEB	0.6157E 03	0.4588E 03	0.1091E 01	0.1182E 00	0.7453E 00
MAR	0.1708E 04	0.9367E 03	0.1792E 01	-0.1194E 00	0.5483E 00
	0.7652E 03	0.9135E 03	0.2127E 01	0.3604E 00	0.1194E 01
	0.9183E 04	0.2950E 04	0.6167E 00	-0.2741E-01	0.3213E 00

STATISTICS FOR ALL SEASONS, OBSERVS. # 720

YEARLY STATISTICS

HISTOGRAMS OF SEASONAL FLOWS FOR 60 YEARS
GRID SPACING FOR 1ST TEN COLUMNS IS 1/100TH OF MAXIMUM SEASONAL FLOW.
GRID SPACING FOR COLUMNS 11-20 IS 1/10TH OF MAXIMUM SEASONAL FLOW

PERCENTILES OF MAXIMUM SEASONAL FLOW

SEASON	1	2	3	4	5	6	7	8	9	10	*	11	12	13	14	15	16	17	18	19	20
APR	0	0	0	0	0	0	0	0	0	1	*	1	9	12	10	7	5	5	7	3	1
MAY	0	0	0	0	0	1	2	3	1	1	*	8	18	9	14	5	4	0	0	1	1
JUNE	0	0	0	0	2	1	2	3	4	6	*	18	22	9	4	3	1	2	0	0	1
JULY	0	0	0	1	0	3	2	0	2	1	*	9	14	15	8	6	2	3	2	0	1
AUG	0	0	0	2	2	2	1	1	2	3	*	13	23	8	7	5	0	3	0	0	1
SEPT	0	0	0	2	0	3	2	3	2	1	*	13	32	9	4	1	0	0	0	0	1
OCT	0	3	4	2	3	2	1	8	4	2	*	29	12	6	9	3	0	0	0	0	1
NOV	1	4	4	3	5	4	5	3	5	1	*	35	13	4	2	3	2	0	0	0	1
DEC	0	1	1	1	3	3	5	4	1	3	*	24	21	7	3	2	0	0	1	1	1
JAN	0	3	6	2	5	1	2	4	1	2	*	26	12	9	5	2	0	1	1	1	3
FEB	0	0	0	0	3	3	1	0	2	2	*	11	13	12	5	10	3	1	3	1	1
MAR	0	0	0	0	0	0	0	0	1	1	*	2	11	18	16	6	3	2	0	0	2

HISTOGRAM FOR ALL SEASONAL EVENTS

30	72	78	63	45	33	26	28	19	21	*	415	126	68	54	19	14	9	6	5	4

HISTOGRAM OF ANNUALS

0	0	0	0	0	0	0	0	0	0	*	0	0	5	11	14	13	7	7	1	2

RANGE FOR EACH SEASONAL HISTOGRAM

0.4673E 04	0.4590E 04	0.1919E 04	0.6589E 03	0.8245E 03	0.7164E 03
0.1705E 04	0.4596E 04	0.3585E 04	0.4930E 04	0.2940E 04	0.5275E 04

RANGE FOR TIME INVARIANT XSEASONALS HISTOGRAM 0.5275E 04 RANGE FOR ANNUAL HISTOGRAM, 0.1754E 05

Output for Option NMP

A. Historical trace

1. Seasonal means, standard deviations, and skewness coefficients for each site.

2. Grand means, standard deviations, and skewness coefficients for each site.

3. Skewness transform diagnostic.

4. Spatial correlation matrix (M_0).

5. Time-space correlation matrix (M_{-1}). The diagonal elements in this matrix are the lag one correlation coefficients for each site. The off-diagonal elements in this matrix are the lag one correlation coefficients of each site with all of its neighbors.

6. Intermediate matrices: A, B, and C.

B. Simulated trace (1st 100 years).

1. As above.

2. As above.

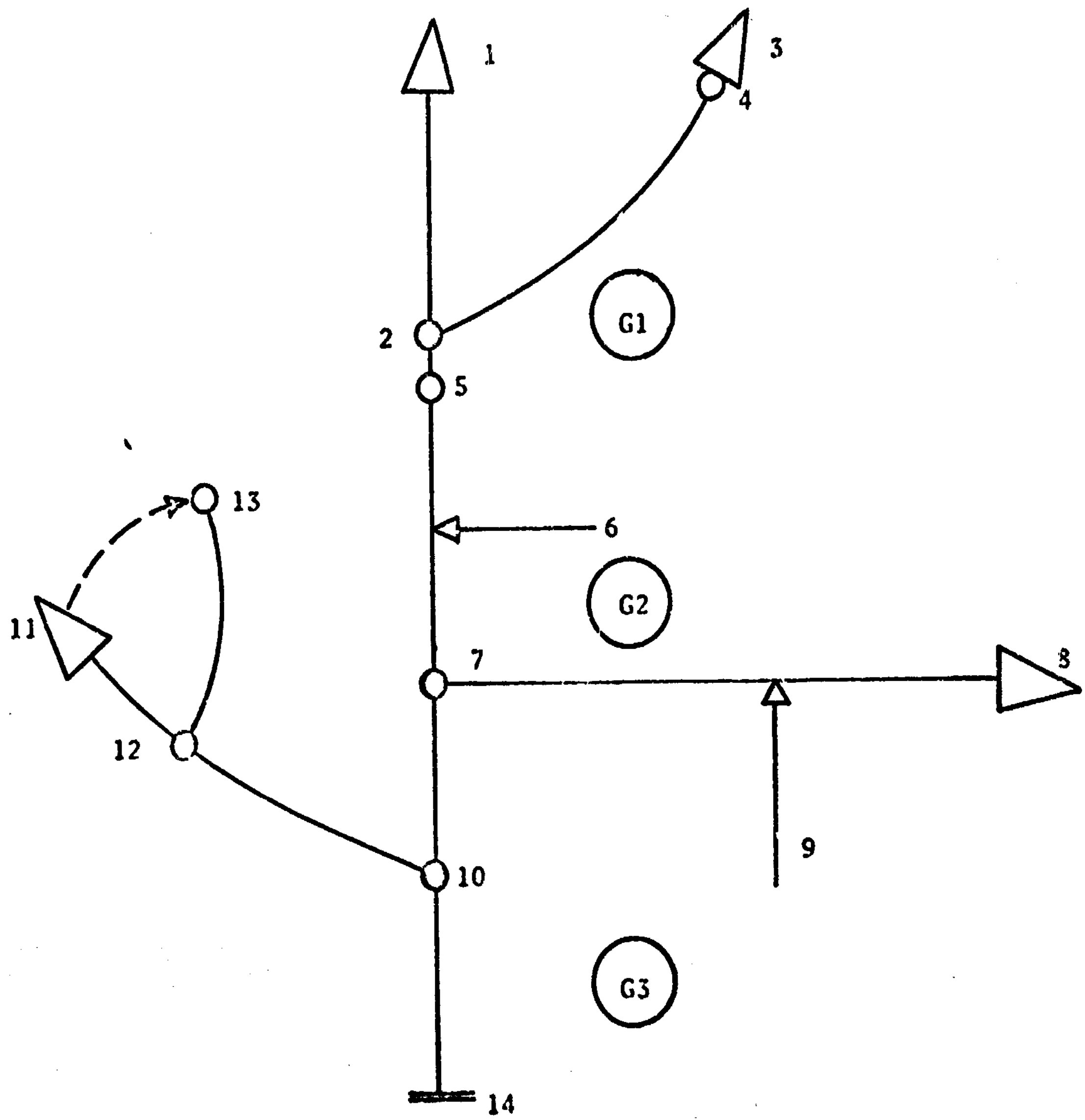
3. Matrices: a) M_0
   b) M_{-1}

OPTION B--

Example Problem

Input - Output

INPUT-OUTPUT - OPTION D



SYSTEM CONFIGURATION OF SAMPLE PROBLEM

Given:

1) Reservoir capacities are 200, 100, 300, and 400 at coordinates 1, 3, 8 and 11, respectively.

2) The starting contents of the reservoirs are 100, 50, 100, and 200, respectively.

3) There are two waste sites in the system located at coordinates 6 and 9. The pollutant flow rate at the first site six is 50 and its concentration is 1200. The pollutant flow rate at coordinate 9 is 100 and its concentration is 300.

4) The test sites at coordinates 4, 2, 5, and 13 have flow requirements of 1000, 250, 350, and 1000, respectively. The test site at coordinate 7 has a water quality standard of 75.

5) The reservoir at coordinate 1 may make channel releases to maintain the flow requirements at the test sites located at coordinates 2 and 5. The storage in the reservoir at coordinate 2 is to be kept half full. The reservoir at coordinate 8 may make channel releases to maintain the water quality standard at coordinate 7. The reservoir at coordinate 11 may make a pipeline withdrawal to maintain the flow requirement at coordinate 13.

6) The concentration of the initial storage in all reservoirs is equal to zero.

7) The unregulated inflow for coordinates 1-5, 6-9, and 10-14, are defined by scaling the flows at gaging stations 1, 2, and 3, respectively. The scaling factors for the 14 coordinates are: 1.,1.,1.,0.,1.,1.,0.,1.,1.,1.,1.,1., 1., and 0. These factors multiplied times the gage flow define the net inflow into each coordinate. This corresponds to choice A in card *6.

8) The background concentration of all the unregulated inflows is equal to zero.

Find: For a routing period of one season, determine the concentration at coordinate 7, the storage levels in all reservoirs, and the tally of deficiencies at all test sites. The gaging station flows are 100, 200, and 300, respectively.

The next two pages are a listing of the card input necessary to study this problem. The ordering of the test and junction points should be carefully noted. The test point at coordinate 4 is the first test site in the system. The test point at coordinate 13 is the 5th test site.

OUTPUT

Page 1 Data echo. Includes: a) title of study; b) years of routing; c) number of pollutants; d) number of years the flow tape is to be skipped forward; e) random number generator trigger; f) starting point in system; g) choice for computing unregulated inflows; and h) tabular map of system.

Pag 2 Data echo. Description of each coordinate.

Page 3 Data echo. Includes: a) coordinate to gaging station reference map; b) gaging station scaling factors for each coordinate; c) routing coefficients (set equal to one in the program); d) reservoir capacities, initial storages, and dead storages; and e) parameters of the seasonal operating rules for the reservoirs.

Page 4 Data echo. Includes: a) number and location of reservoirs that may make channel releases to flow requirements or water quality standards at specified test sites; b) allocation option - mode of calculating releases for more than one reservoir serving a test site; c) test site (number and location) that may receive pipeline supplements from dam site (number and location); d) evaporation of storage in reservoir option; and e) concentration of starting storages.

Page 5 Data echo. Includes: a) minimum waste flow rate and minimum pollutant weight for each waste site; b) seasonal means flow rate, standard deviation of flow rate, seasonal mean waste weight for each pollutant, seasonal standard deviation of waste weight for each pollutant (note - for the 1st waste site at coordinate 6, the waste weight is 30000(100*300)); seasonal mean and standard deviation of flow requirements for each test site; and d) seasonal water quality standards for each test site.

```
5
EXAMPLE RIVER BASIN USING OPTION B.                                                     CARD 1
   14     1     1     3     1                                                           CARD 2
    3     4     3     1     1     2     4     3     2     4                             CARD #3
    3     4     1     5                                                                 CARD #3
    2     5     4     2     6     7    10     9     7    14                             CARD #4
   12    10    17     0                                                                 CARD #4
    1     1     1     1     1     2     2     2     2     3                             CARD #5
    3     3     3     3                                                                 CARD #5
          1           1           1           0           1                             CARD #6A
          1           0           1           1           1                             CARD #6A
          1           1           1           0                                         CARD #6A
    3     8    11    13                                                                 CARD 7
    1     1     5     0     0.    0     0     1    19     0     1     0     0           CARD 8
                                                                                        CARD #9
                                                                                        CARD #9
     DAM AT COORDINATE 1                                                                CARD #10
     JUNCTION POINT AT COORDINATE 2                                                     CARD #10
     DAM AT COORDINATE 3                                                                CARD #10
     TEST SITE AT COORDINATE 4                                                          CARD #10
     TEST SITE AT COORDINATE 5                                                          CARD #10
     WASTE SITE AT COORDINATE 6                                                         CARD #10
     TEST SITE AT COORDINATE 7                                                          CARD #10
     DAM AT COORDINATE 8                                                                CARD #10
     WASTE SITE AT COORDINATE 9                                                         CARD #10
     JUNCTION POINT AT COORDINATE 10                                                    CARD #10
     DAM AT COORDINATE 11                                                               CARD #10
     JUNCTION POINT AT COORDINATE 12                                                    CARD #10
     TEST SITE AT COORDINATE 13                                                         CARD #10
     END POINT AT COORDINATE 14                                                         CARD #10
      200        100        300        400                                              CARD #11
        0         .0          0          0                                              CARD #12
      100         50        100        200                                              CARD #13
        0                                                                               CARD #14
        0                                                                               CARD #14
        0                                                                               CARD #14
-.5                                                                                     CARD #14
        0                                                                               CARD #14
        0                                                                               CARD #14
        0                                                                               CARD #14
        0                                                                               CARD #14
        0                                                                               CARD #14
        0                                                                               CARD #14
        0                                                                               CARD #14
        0                                                                               CARD #14
    0   0     0    13                                                                   CARD #17
        0          0                                                                    CARD 18
        0                                                                               CARD #19
        0                                                                               CARD #19
       50                                                                               CARD #20
```

```
     0                              CARD #20
 60000                              CARD #20
     0                              CARD #20
   100                              CARD #20
     0                              CARD #20
 30000                              CARD #20
     0                              CARD #20
   0     1     1     1     0     0     0    CARD #21
   1                                CARD #22
   1                                CARD #22
   8                                CARD #22
  1000                              CARD #23
     0                              CARD #23
     0                              CARD #23
   250                              CARD #23
     0                              CARD #23
     0                              CARD #23
   350                              CARD #23
     0                              CARD #23
     0                              CARD #23
     0                              CARD #23
     0                              CARD #23
    75                              CARD #23
  1000                              CARD #23
     0                              CARD #23
     0                              CARD #23
     0                              CARD #23
     0                              CARD #23
     0                              CARD #23
     0                              CARD #23
     0                              CARD #23
     0                              CARD #23
     0                              CARD #33
     0                              CARD #33
     0                              CARD #33
     0                              CARD #33
   0                                CARD #34
    0      0      0                 CARD #45
  100    200    300                 CARD #46
```

EXAMPLE RIVER BASIN USING OPTION B.

RUN 1 OF 1

1

1 YEARS OF RECORD 1 WASTE VARIABLES

TAPE 5 TO BE SKIPPED 0 RECORDS

RANDOM NUMBER GENERATOR TRIGGER 19

STARTING POINT IN SYSTEM 1 UNREGULATED FLOW OPTION 0

14 POINTS 4 DAMS 3 TESTS 2 WASTES

COORDINATE	TYPE	SUM TYPE	NEXT LOCATION	STARTING POINT OF NEW BRANCH
1	DAM	1	2	
2	MERGE	1	5	3
3	DAM	2	4	
4	TEST	1	2	
5	TEST	2	6	
6	WASTE	1	7	
7	MERGE	2	10	8
8	DAM	3	9	
9	WASTE	2	7	
10	MERGE	3	14	11
11	DAM	4	12	
12	MERGE	4	10	13
13	TEST	3	12	
14	END			

2

DESCRIPTION OF EACH COORDINATE

1	DAM AT COORDINATE 1
2	JUNCTION POINT AT COORDINATE 2
3	DAM AT COORDINATE 3
4	TEST SITE AT COORDINATE 4
5	TEST SITE AT COORDINATE 5
6	WASTE SITE AT COORDINATE 6
7	TEST SITE AT COCRINATE 7
8	DAM AT COORDINATE 8
9	WASTE SITE AT COORDINATE 9
10	JUNCTION POINT AT COORDINATE 10
11	DAM AT COORDINATE 11
12	JUNCTION POINT AT COORDINATE 12
13	TEST SITE AT COORDINATE 13
14	END POINT AT COORDINATE 14

DATA ECHO

3.

CORD. GAGE REFERENCE DRAINAGE RATIO ROUTING COEF.

1	1	1.0000	1.000
2	1	1.0000	1.000
3	1	1.0000	1.000
4	1	0.0	1.000
5	1	1.0000	1.000
6	2	1.0000	1.000
7	2	0.0	1.000
8	2	1.0000	1.000
9	2	1.0000	1.000
10	3	1.0000	1.000
11	3	1.0000	1.000
12	3	1.0000	1.000
13	3	1.0000	1.000
14	3	0.0	1.000

DAM	CAP.	INI. STOR	DEAD
1	0.2000E 03	0.1000E 03	0.0
2	0.1000E 03	0.5000E 02	0.0
3	0.3000E 03	0.1000E 03	0.0
4	0.4000E 03	0.2000E 03	0.0

SEASONAL OPERATING RELEASE RULES FOR EACH RESERVOIR

DAM			
1	0.0	0.0	0.0
2	-0.500	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0

4.

```
T.P.  NUMBER DAMS SERVICING **** LOCATIONS          ALLOCATION OPTION   0
  2          1                    1
  3          1                    1
  4          1                    8

TEST POINTS THAT RECEIVE CONDITIONAL DIVERSIONS FROM A DAM AT THE FOLLOWING LOCATION//

T.P.    CO     DAM     CO


  5     13      4      11

EVAPOR.   0

INITIAL CONC. IN DAMS

   1          0.0
   2          0.0
   3          0.0
   4          0.0
```

5.

```
SITE MIN. FLOW THEN MIN. WT
    1         0.0         0.0
    2         0.0         0.0
SITE WASTE     SEASONAL MEAN Q. SD Q. MEAN WT. . SD WT.

  1

      1    50.0      0.0   60000.0     0.0
  2

      1   100.0      0.0   30000.0     0.0
T.P.  SEASONAL MEAN FLOW REQU. THEN SEASONAL STD. FLOW / EQU.

  1  1000.000     0.0
  2   250.000     0.0
  3   350.000     0.0
  4     0.0       0.0
  5  1000.000     0.0
  6     0.0       0.0
  7     0.0       0.0
TP  WASTE     SEASONAL QUALITY TARGETS

       1          0.0
       1          0.0
       1          0.0
       1         75.0
       1          0.0
       1          0.0
       1          0.0
```

Page 6 Tally of deficiencies. On the left half of the page is the number of seasonal deficiencies for each test site in the system. A deficiency is tallied whenever any of the water water quality standards or flow requirement at a test site has not been maintained. On the right half of the page is the number of times that the critical or greatest failure was attributed to the water quality standards or flow requirement. The count is independent of season. In the second line there is an entry entitled "shortage". This is a count of the number of times when there was a deficiency at a test site and that there was available storage in any of the specified reservoirs to satisfy this deficiency. This occurs when reservoirs in series have been specified to satisfy by channel releases downstream test sites.

Page 7 Probability of misses. The probabilities of seasonal deficiencies, critical failures, and yearly failures are presented. A yearly failure is counted when the water quality standards or flow requirement for any season during a year is not maintained.

If all the print suppress options have been depressed, then the output terminates with page 7. The output for the second run in a multi-run job begins with page 2; that is, all the design information is reprinted.

Page 8 Seasonal deficiency summary. The number of misses, the mean of the misses, the standard deviation, and the probability of failure is presented for each water quality standard and flow requirement. A water quality standard deficiency or miss is the amount of dilution water needed to lower the test site concentration down to the level of the standard. The calculation assumes that the concentration of the diluting water is equal to zero. Later output will give the means and standard deviations of the pollutant concentrations in the reservoirs. Non-zero punches in columns 40, 45, and 50 in the first card of *9 and in columns 5, 10, and 15 of the second card of *9 will suppress this output.

Page 9 Maximum seasonal deficiency summary. This is a summary of all the maximum seasonal failures. The number of failures, the mean, the standard deviation, the probability, and the maxima is presented. Note that the sum of all the seasonal failures shown on page 6 for a test site must equal the number of deficiencies shown here. A non-zero punch in column 20 in the second card of *9 will suppress this output.

OUTPUT SUMMARY FOR RUN. 1

ROUTING OF 1 YEARS OF 1 SEASONS 0 SHORTAGES 6.

TEST	COORD	NUMBER OF SEASONAL DEFICIENCIES											NUMBER OF CRITICAL DEFICIENCIES FOR ALL SEASONS ATTRIBUTED TO TARG 1	TARG 2	TARG 3	TARG 4	TARG 5	FLOW REQD
		SEASON 1																
1	4	1	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	1
2	2	0	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0
3	5	0	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0
4	7	0	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0
5	13	1	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	1
6	12	0	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0
7	10	0	0	0	0	0	0	0	0	0	0	0	0*	0	0	0	0	0

7.

TEST CO — PROB. OF SEASONAL DEFICIENCIES — PROB. OF CRIT. DEFICIENCIES FOR ALL SEASONS ATTRIBUTED TO

TEST	CO	SEASON 1												TARG 1	TARG 2	TARG 3	TARG 4	TARG 5	FLOW REQD
1	4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0*	0.0	0.0	0.0	0.0	0.0	100.0
2	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0*	0.0	0.0	0.0	0.0	0.0	0.0
3	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0*	0.0	0.0	0.0	0.0	0.0	0.0
4	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0*	0.0	0.0	0.0	0.0	0.0	0.0
5	13	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0*	0.0	0.0	0.0	0.0	0.0	100.0
6	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0*	0.0	0.0	0.0	0.0	0.0	0.0
7	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0*	0.0	0.0	0.0	0.0	0.0	0.0

PROBABILITY OF YEARLY FAILURE

TEST	CO	
1	4	100.0
2	2	0.0
3	5	0.0
4	7	0.0
5	13	100.0
6	12	0.0
7	10	0.0

8.

SEASONAL DEFICIENCY STATISTICS SUMMARY

FOR 1 YEARS

SEASON 1

TEST SITE	COORDINATE	WASTE	DEFS	MEAN	STD DEVN	PROB	WASTE 6 IS FLOW TARGET
1	4	1	0	0.0	0.0	0.0	
1	4	6	1	0.900E 03	0.0	100.00	
2	2	1	0	0.0	0.0	0.0	
2	2	6	0	0.0	0.0	0.0	
3	5	1	0	0.0	0.0	0.0	
3	5	6	0	0.0	0.0	0.0	
4	7	1	0	0.0	0.0	0.0	
4	7	6	0	0.0	0.0	0.0	
5	13	1	0	0.0	0.0	0.0	
5	13	6	1	0.3000E 03	0.0	100.00	
6	12	1	0	0.0	0.0	0.0	
6	12	6	0	0.0	0.0	0.0	
7	10	1	0	0.0	0.0	0.0	
7	10	6	0	0.0	0.0	0.0	

SEASONAL COMPOSITE OF MAXIMUM DEFICIENCIES

9.

TEST SITE	COORDINATE	DEFS	MEAN	STD DEVN	PROB	MAXIMA
1	4	1	0.9000E 03	0.0	100.00	0.9000E 03
2	2	0	0.0	0.0	0.0	0.0
3	5	0	0.0	0.0	0.0	0.0
4	7	0	0.0	0.0	0.0	0.0
5	13	1	0.3000E 03	0.0	100.00	0.3000E 03
6	12	0	0.0	0.0	0.0	0.0
7	10	0	0.0	0.0	0.0	0.0

Page 10 <u>Yearly deficiency summary</u>. The number of yearly failures, the mean, the standard deviation, the probability, and the maxima of the yearly failures is shown for each test site. A yearly failure is the sum of all the maximum seasonal failures during that year. A non-zero punch in column 25 in the second card of *9 will suppress this output.

Page 11 <u>Reservoir performance summary</u>. Shown on this page are the number of times the reservoirs spilled and the number of times they were depleted down to dead storage or emptied. A spill is tallied when the total assets (inflow plus start of the season storage) exceed the sum of all the withdrawals and releases and the capacity of the reservoir. A non-zero punch in column 30 of the second card of *9 will suppress this output.

Page 12 <u>Reservoir performance summary - distribution of storage levels</u>. The mean and the histogram of storage volumes for each reservoir for each season is presented. The capacity of the reservoir is the range of the histogram. If twelve seasons had been specified, then 11 more pages would follow. A non-zero punch in column 30 in the second card of *9 will suppress this output.

Page 13 <u>Distributions of maximum seasonal deficiencies</u>. The maximum seasonal failure, the accumulative histogram, the mean, and the standard deviation of the maximum failures for each season is presented for each test site.

The range of the histogram is the maxima seasonal failure. If 12 seasons had been specified, then 11 more pages would follow. A non-zero punch in column 35 in the first card of *9 will suppress this output.

Page 14 <u>Distributions of maximum yearly deficiencies</u>. The accumulative histograms of annual failures are shown for each site. The range of the histogram is the maxima of the yearly failures. A non-zero punch in column 25 in the second card of *9 will suppress this output.

10.

YEARLY MAXIMUM DEFICIENCIES

TEST SITE	COORDINATE	DEFS	MEAN	STD DEVN	PROB	MAXIMA
1	4	1	0.9000E 03	0.0	100.00	0.9000E 03
2	2	0	0.0	0.0	0.0	0.0
3	5	0	0.0	0.0	0.0	0.0
4	7	0	0.0	0.0	0.0	0.0
5	13	1	0.3000E 03	0.0	100.00	0.3000E 03
6	12	0	0.0	0.0	0.0	0.0
7	10	0	0.0	0.0	0.0	0.0

11.

STATISTICAL SUMMARY FOR DAM SITES

DAM NUMBER	COORDINATE	EMPTIES	SPILLS
1	1	0	0
2	3	0	0
3	6	0	0
4	11	1	0

DISTRIBUTIONS OF STORAGE LEVELS, SEASON 1 12.

SITE	CAPACITY	DEAD STORAGE	MEAN	EMPTY	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.FULL
1	200.	0.0	150.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0	0.0	
2	100.	0.0	50.	0.0	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	
3	300.	0.0	0.	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4	400.	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

ELEMENTS IN EACH ROW ARE THE PROBS. ASSOCIATED WITH PERCENTAGES OF CAPACITY SHOWN

SEASON 1

DISTRIBUTIONS OF MAXIMAL SEASONAL DEFICIENCIES

FOR 1 YEARS

ELEMENTS IN FIRST ROW ARE ACCUMULATIVE PROBABILITIES
ELEMENTS IN 2ND ROW ARE CORRESPONDING INTERMEDIATE RANGES

TP	CO	MAX.											MEAN	S.D.
1	4	0.9000E 03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000*	0.9000E 03	0.0
			90.	180.	270.	360.	450.	540.	630.	720.	810.	900.		
2	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 *	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
3	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 *	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
4	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 *	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
5	13	0.3000E 03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000*	0.3000E 03	0.0
			30.	60.	90.	120.	150.	180.	210.	240.	270.	300.		
6	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 *	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
7	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 *	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

DISTRIBUTIONS OF MAXIMUM YEARLY DEFICIENCIES
ELEMENTS IN FIRST ROW ARE ACCUMULATIVE PROBABILITIES
ELEMENTS IN 2ND ROW ARE CORRESPONDING INTERMEDIATE RANGES

TEST	COORD	MAX.										
1	4	0.9000E 03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000
			90.	180.	270.	360.	450.	540.	630.	720.	810.	900.
2	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	13	0.3000E 03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000
			30.	60.	90.	120.	150.	180.	210.	240.	270.	300.
6	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Page 15 Histograms of deficiencies for water quality standards. The histograms of deficiencies for water quality standard 1 are shown. The range of each histogram appears directly below. If 12 seasons had been specified, then 11 more pages would follow. If more than one pollutant had been specified, then the series of pages would be repeated. Non-zero punches in columns 5, 10, 15, and 20 in the first card of *9 will suppress this output.

Page 16 Histograms of seasonal deficiencies for flow requirement. The histograms of deficiencies for the flow targets at each of the test sites are shown on this page. The range of each histogram is the maximum seasonal miss and is shown directly below. If 12 seasons had been specified, then 11 more pages would follow. A non-zero punch in column 30 of the first card of *9 will suppress this output.

Page 17 Seasonal statistics of system flows. The maximum flow, the histograms, the mean, and the standard deviation of the seasonal flows for each coordinate are presented. The range of the histograms are the maximum seasonal flows. At test sites the lower fifth of the histogram, that is, the flows between zero and 0.2 of the seasonal maximum, are further subdivided into fifths. This is designated by "LOW FIF." at each of the test and junction points. If 12 seasons had been specified, then 11 more pages would follow. A non-zero punch in column 35 in the second card of *9 will suppress this output.

Page 18 Grand means and standard deviations. The mean and standard deviation for all seasons is presented for each test site. A non-zero punch in column 35 in the second card of *9 will suppress this output.

Page 19 System concentration summary. For each test site the mean and the standard deviation of the system concentration for the pollutant is shown. If 12 seasons had been specified, then 11 more columns of means and standard deviations would appear. If more than one pollutant had been specified, then another page(s) would follow. A non-zero punch in column 40 in the second card of *9 will suppress this output.

Page 20 Distribution of system concentrations. The minimum, the histogram, and the maximum of the system concentrations is presented for each test site. The range of the histogram is the maximum concentration less the minimum concentration. The histogram is formed over all seasons. If more than one

15

HISTOGRAM OF SEASONAL DEFICIENCIES ATTRIBUTED TO WASTE VARIABLE 1

FOR 1 YEARS

SEASON 1

SITE	COORD	FIFTH	1	2	3	4	5	SITE	COORD	FIFTH	1	2	3	4	5
1	4		0	0	0	0	0	2	2		0	0	0	0	0
3	5		0	0	0	0	0	4	7		0	0	0	0	0
5	13		0	0	0	0	0	6	12		0	0	0	0	0
7	10		0	0	0	0	0								

MAXIML DEF. . ORDER IS BY SITE

0.0 0.0 0.0 0.0 0.0 0.0
0.0

16

HISTOGRAM OF SEASONAL DEFICIENCIES ATTRIBUTED TO A QUALITY FLOW REQUIREMENT OR A WATER SUPPLY NEED

FOR 1 YEARS

SEASON 1

SITE	COORD	FIFTH 1	2	3	4	5	SITE	COORD	FIFTH 1	2	3	4	5
1	4	0	0	0	0	1	2	2	0	0	0	0	0
3	5	0	0	0	0	0	4	7	0	0	0	0	0
5	13	0	0	0	0	1	6	12	0	0	0	0	0
7	10	0	0	0	0	0							

MAXIMUM DEF. , ORDER IS BY SITE

0.90000E 03   0.0   0.0   0.0   0.30000E 03   0.0
0.0

SEASONAL STATISTICS FOR ROUTED SYSTEM FLOWS

FOR 1 YEARS

17.

SEASON 1 14 POINTS

COORD	MAX FLOW PAST	FIFTH	1	2	3	4	5	MEAN FLOW	S.D. FLOW
1	0.5000E 02		0	0	0	0	1	0.5000E 02	0.0
2	0.2500E 03		0	0	0	0	1	0.2500E 03	0.0
		LOW FIF.	0	0	0	0	0		
3	0.1000E 03		0	0	0	0	1	0.1000E 03	0.0
4	0.1000E 03		0	0	0	0	1	0.1000E 03	0.0
		LOW FIF.	0	0	0	0	0		
5	0.3500E 03		0	0	0	0	1	0.3500E 03	0.0
		LOW FIF.	0	0	0	0	0		
6	0.6000E 03		1	0	0	0	0	0.6000E 03	0.0
7	0.1200E 04		0	0	0	0	1	0.1200E 04	0.0
		LOW FIF.	0	0	0	0	0		
8	0.3000E 03		1	0	0	0	0	0.3000E 03	0.0
9	0.6000E 03		0	0	0	0	1	0.6000E 03	0.0
10	0.2600E 04		0	0	0	0	1	0.2600E 04	0.0
		LOW FIF.	0	0	0	0	0		
11	0.1000E 03		0	0	0	0	1	0.1000E 03	0.0
12	0.1100E 04		0	0	0	0	1	0.1100E 04	0.0
		LOW FIF.	0	0	0	0	0		
13	0.7000E 03		0	0	0	0	1	0.7000E 03	0.0
		LOW FIF.	0	0	0	0	0		
14	0.2600E 04		1	0	0	0	0	0.2600E 04	0.0

GRAND MEANS AND STD. DEVNS.

COORD

1	0.5000E 02	0.0
2	0.2500E 03	0.0
3	0.1000E 03	0.0
4	0.1000E 03	0.0
5	0.3500E 03	0.0
6	0.6000E 03	0.0
7	0.1200E 04	0.0
8	0.3000E 03	0.0
9	0.6000E 03	0.0
10	0.2600E 04	0.0
11	0.1000E 03	0.0
12	0.1100E 04	0.0
13	0.7000E 03	0.0
14	0.2600E 04	0.0

SYSTEM QUALITY ANALYSIS 19.

SEASONAL MEANS AND STD DEVNS AT TEST POINTS AND JUNCTION POINTS
FOR WASTE VARIABLE 1
FOR 1 YEARS

SITE	COORD.	SEASON 1
1	4	0.0 0.0
2	2	0.0 0.0
3	5	0.0 0.0
4	7	75.6 0.0
5	13	0.0 0.0
6	12	0.0 0.0
7	10	34.6 0.0

20.

DISTRIBUTIONS OF SYSTEM CONCENTRATIONS AT TEST SITES
ELEMENTS IN FIRST ROW ARE ACCUMULATIVE PROBABILITIES, ELEMENTS IN 2ND ROW ARE CORRESPONDING INTERMEDIATE RANGES

TEST PT.	COORD.	WASTE	MINIMUM											MAXIMUM
1	4	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	2	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	5	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4	7	1	75.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.00
				75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	
5	13	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6	12	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7	10	1	34.62	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.62
				34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	

pollutant were specified, then another page(s) would follow. A non-zero punch in colum 40 in the second card of *9 will suppress this output.

Page 21 Concentration of pollutants at reservoirs. Shown for each reservoir is the mean and the standard deviation of the pollutant for all seasons. If more than one pollutant had been specified, then the mean and standards deviation for each site would be grouped together. A non-zero punch in column 40 in second card of *9 will suppress this output.

Page 22 Distribution of concentrations at the dam sites. The minimum concentration, the histogram, and the maximum concentration is shown for each reservoir site. The histogram is formed over all seasons and its range is the maximum concentration less the minimum concentration. Histograms for other pollutants would appear on other pages. A non-zero punch in column 45 in the second card of *9 will suppress this output.

CONCENTRATIONS OF POLLUTANTS AT DAMSITES 21.

DAM	COORD	WASTE	MEAN	STANDARD DEVN.
1	1	1	0.0	0.0
2	3	1	0.0	0.0
3	8	1	0.0	0.0
4	11	1	0.0	0.0

22.

DISTRIBUTIONS OF CONCENTRATIONS AT DAMSITES
ELEMENTS IN FIRST ROW ARE ACCUMULATIVE PROBABILITIES, ELEMENTS IN 2ND ROW ARE CORRESPONDING INTERMEDIATE RANGES

DAM	COORD	WASTE	MINIMUM											MAXIMUM
1	1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	3	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	6	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4	11	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

APPENDIX

Listing of Option D.

Listing of Option NMP.

Listing of Option B.

Option D Listing

DEM ..... (Main)

Subroutines

READ

STAT

SEAMON

PRIN1

XBARSD

XSKEW

XCOR

HIST

TRANS

SETUP

CLT24

GENFLO

BACTAN

ROUTE

PROCES

FAILDR

ABTRAC

OUTPUT

OUTPLT

FIRST

PAGE

PRPLOT

```
      DIMENSION FLOHIS(100,12),DAR(12),COEUNR(12),XM(12),SD(12),
     1WILSON(12),COR(12),REG(12),SE(12),FLOW(12),          YY(100,12),
     2XMTAN(12),SDTAN(12),SDDIR(12),XMDIR(12),UNREG(12),TARGET(12),DIV(
     312),RELA(12),RELB(12),RELC(12),XMISS(12),STVOL(12),HISMIS(250,12),
     4HISMS(13,10),ANNMIS(250),SEAMIS(12,5),AMOMIS(5),FLXM(12),FLSD(1.',
     5HISTOR(12,10),NNNN(36,3),SAVE(36),CAP(10),"TOR(10),KIND(18)
      DIMENSION ISKIP(15),DATF(12),DATI(12)
      DATADATE/:JAN :,:FEB :,:MAR :,:APR :,:MAY :,:JUNE:,:JULY:,:AUG :,
     1:SEPT:,:OCT :,:NOV :,:DEC :/
C***********************************************************************
C     *                                                                *
C     *                                                                *
C     *                                                                *
C     *                                                                *
C     NEW MODEL UFM- 4/68-  W.C.PISANO- TECHNICAL CONTROL DIVISION-FWPCA
C     ORIGINAL VERSION- 9/66- M.B FIERING- HARVARD UNIVERSITY
C     *                                                                *
C     *                                                                *
C     *                                                                *
C     *                                                                *
C***********************************************************************
      NPAGE=0
      CALL PAGE(NPAGE)
C     NOTES ON FLOW GENERATING OPTIONS.
C
C     A.- TWO MODELS CAN BE USED.
C         1- CYCLICAL SEASONAL MARKOVIAN MODEL (THOMAS AND FIERING)
C         2. TIME INVARIANT RESIDUAL MODEL (YOUNG+PI..NO)
C     B. PARAMETERS CAN BE COMPUTED FROM RAW DATA OR OPTIONALLY, BE INPU
C     C. IF RAW DATA IS SUPPLIED, THEN THE PROGRAM TRIES THREE TRANSFORM
C     TO MINIMIZE SKEWNESS(NONE,SQRT,LOG10) AND COMPUTES THREE T-
C     DIAGNOSTICS(SKEW/STD.ERR,SKEW). IT PICKS THE TRANSFORM THAT PRODUC
C     MINIMUM SKEWNESS(LOWEST T)IF ITS ABSOLUTE VALUE IS LESS THAN 1.65
C     (SEE TECHNICAL NOTE-YOUNG, MARCH 1967). FLOWS WILL BE GENERATED
C     USING THIS OPTION. IF T IS GREATER THAN 1.65, THEN THE WILSON-
C     HILFERTY TRANSFORM IS USED TO GENERATE GAMMA-DISTRIBUTED FLOWS.
C     D.- IF MOMENTS ARE SUPPLIED , THEN THE DISTRIBUTION MUST ALSO BE
C     INPUTED.
C
C
C     SUBROUTINE READ- INPUTS HISTORICAL FLOWS,AREAL TRANSLATION COEFS.,
C    1FLOW GENERATOR CONTROLS. AND OPTIONALLY, STATISTICS FOR FLOW
C     GENERATOR.
      CALL READ(FLOHIS,NYRS,NSEAS,DAR,COEUNR,ISTRUT,IPARM,IDIST,XM,SD,
     1WILSON,COR,REG,SE,A11,B11,WIL,NPAGE,IFIRST)
C
C     ARRANGES MONTHS IN DATI FOR PRINTING
C
      DO 30 I=1,12
      J=I
```

```
      CALL FIRST(IFIRST,12,J)
   30 DAT1(I)=DATE(J)
C
C
C     IPARM- FLOW GENERATOR PARAMETER KEY
C     IF 1- PARAMETERS ARE INPUT
C
      IF(IPARM)1,1,2
    1 IHIST=1
C
C
C     SUBROUTINE STAT- COMPUTES STATISTICS OF HISTORICAL TRACE FOR DISPL
C     AND NECESSARY STATISTICS FOR FLOW GENERATOR.
C
      CALL STAT(FLOHIS,NYRS,NSEAS,IDIST,ISTRUT,IPARM,XM,SD,COR,REG,SE,
     1A11,B11,WIL,WILSON,IHIST,DAT1,NPAGE,YSTART)
C
C
C
C     NDIL- NUMBER OF DILUTION REQUIREMENT VECTORS.
C     ALL DAM SIZES WILL CYCLE FOR EACH DILUTION VECTOR.
C
C
C     NSIM- SIMULATED YEARS OF ROUTING
C
C
C     NSIZES- NUMBER OF RESERVOIRS CONSIDERED.
C
C
C     IRPAT- RANDOM NUMBER GENERATOR TRIGGER.
C
C
C     IOPT- RESERVOIR OPERATING POLICY OPTIONS.
C     1. SUPPLY ON DEMAND
C     2. INPUT RULE CURVE OPERATION.
C     3. INPUT RULE CURVES THAT CAN BE OVERRIDEN BY DOWNSTREAM DEMAND.
C
C
C     ITRIG- FLAG TO INDICATE THAT SAME OPERATIONAL TRACE IS TO BE USED
C     FOR EACH ROUTING SEQUENCE.
C
C
C     JHIS- BYPASSING OF HISTORICAL FLOW ROUTING OPTION.
C
C
C
C     PROGRAM CYCLE POINT FOR NEW SET OF DAMS AND DILUTION REQDS.
C
    7 READ(5,4,END=99)NDIL,NSIM,NSIZES,IRPAT,IOPT,ITRIG,JHIS
    4 FORMAT(10I5)
```

D 2

```
C
C     ISKIP- PRINT SURPRESS VECTOR.
C
      READ(5,12)(ISKIP(I),I=1,15)
 12   FORMAT(15I2)
C
C     CAP- TOTAL CAPACITY OF EACH RESERVOIR TO BE CONSIDERED.
C
      READ(5,3)(CAP(ISIZE),ISIZE=1,NSIZES)
C
C     STOR- STARTING STORAGE FOR EACH RESERVOIR.
C
      READ(5,3)(STOR(ISIZE),ISIZE=1,NSIZES)
  3   FORMAT(12F6.0)
      IF(IOPT-2)5,6,6
C
C     RELA,RELB,RELC- WHEN OPTION TWO AND THREE ARE USED FOR OPERATING
C     RESERVOIRS, SEASONAL RELEASES ARE COMPUTED BY- RELEASE(I)=
C     RELA(I) + RELB(I)*INFLOW(I) + RELC(I)*STORAGE(I)
C
  6   READ(5,3)(RELA(ISEAS),ISEAS=1,NSEAS)
      READ(5,3)(RELB(ISEAS),ISEAS=1,NSEAS)
      READ(5,3)(RELC(ISEAS),ISEAS=1,NSEAS)
C
C     SUBROUTINE PAGE- FLIPS AND NUMBERS PAGES.
C
      CALL PAGE(NPAGE)
      WRITE(6,13)NSIZES,IOPT,(I,CAP(I),STOR(I),I=1,NSIZES)
 13   FORMAT(1H030HNUMBER OF DAM SIZES CONSIDERED,2X,I4/1H 11HRULE OPTIO
     1N,2X,I4/1H04HSIZE,10X,8HCAPACITY,10X,15HINITIAL STORAGE/1H
     2 I4,10X,F8.0,10X,F8.0)
      WRITE(6,14)(RELA(I),I=1,NSEAS),(RELB(I),I=1,NSEAS),(RELC(I),I=1,
     1NSEAS)
 14   FORMAT(1H024HSEASONAL OPERATING RULES//1H (12F10.3))
C
C     SAVING RANDOM NUMBER TRIGGER
C
  5   IF(ITRIG)15,15,16
 16   IPAT=IRPAT
C
C
C     INITIALIZING FLOW FOR FLOW GENERATOR.
C
C
C     ISTRUT- FLOW GENERATOR MODEL KEY.
C
 15   IF(ISTRUT-2)24,25,25
 25   YSTART=0.0
      GO TO 26
 24   IF(IRAND)27,27,28
```

```
28    YSTART=XM(NSEAS)
27    YSAV=YSTART
C
C     CYCLE ON DILUTIONS VECTORS.
C
26    DO 7 IDIL=1,NDIL
      IDIL=IDIL
C
C     KIND- DESCRIPTION FOR EACH DILUTION VECTOR.
C
      READ(5,8)(KIND(I),I=1,18)
8     FORMAT(18A4)
C
C     XMTAR- SEASONAL MEAN FLOW TARGETS.
C
      READ(5,3)(XMTAR(ISEAS),ISEAS=1,NSEAS)
C
C     SDTAR- SEASONAL STD. DEVNS. OF FLOW TARGETS.
C
      READ(5,3)(SDTAR(ISEAS),ISEAS=1,NSEAS)
C
C     XMDIR- SEASONAL MEAN DIVERSIONS AT DAMSITE.
C
      READ(5,3)(XMDIR(ISEAS),ISEAS=1,NSEAS)
C
C     SDDIR- SEASONAL STD. DEVNS. OF DIVERSION AT DAMSITE.
C
      READ(5,3)(SDDIR(ISEAS),ISEAS=1,NSEAS)
C
C
C     CYCLE ON DAM SIZES
C
      DO 7 ISIZE=1,NSIZES
      ISIZE=ISIZE
      C=CAP(ISIZE)
      ST=STOR(ISIZE)
      STK=STOR(ISIZE)
C
C     BEGIN HISTORICAL FLOW ROUTING ANALYSIS.
C
      IF(JHIS)22,22,23
22    DO 9 IY=1,NYRS
C
C     IY- YEAR INDEX.
C
      IY=IY
C
C     HISTORICAL TRACE FLAG.
C
      KEY=0
```

D 4

```
C
C     SUBROUTINE SETUP- COMPUTES SEASONAL INFLOWS TO DAMSITE, DIVERSIONS
C     UNREGULATED FLOWS BETWEEN DAM AND TARGET POINT, AND TARGETS.
C
      CALL SETUP(FLOHIS,CUEUNR,FLOW,XMTAR,SDTAR,XMDIR,SDDIR,NSEAS, UNREG,
     1TARGET,DIV,KEY,IY,0)
C
C     SUBROUTINE ROUTE- PERFORMS ROUTING, ONE YEAR AT A TIME.
C     RETURNS STORAGE VOLUMES, MISSES, FLOWS PAST TARGET POINT.
C
      CALL ROUTE(FLOW,UNREG,TARGET,DIV,C,ST,RELA,RFLB,RELC,XMISS,STVOL,
     1NSEAS,IOPT)
C
C     SUBROUTINE PROCES- COMPUTES SUMMING STATISTICS OF STORAGE VOLUMES,
C     ONE- SEASONAL MISSES, AND FLOWS PAST TARGET POINT.
C
      CALL PROCES(FLOW,XMISS,STVOL,C,NSEAS,HISMIS,HISMS,ANNMIS,SEAMIS,
     1ANMHIS,FLXM,FLSD,HISTOR,IY,OUTTAP,NYRS)
C
C     SUBROUTINE FAILOR- COMPUTES FAILURE DURATIONS OF UP TO 36 SEASONS.
C
    9 CALL FAILOR(DURN,XMISS,IFLAG,SAVE,NSEAS,IY)
C
C     END HISTORICAL FLOW ROUTING.
C
C
C     SUBROUTINE ANTRAC -COMPUTES STATISTICS OF ONE-SEASONAL FAILURES,
C     ANNUAL FAILURES, DURATION FAILURES, AND SEASONAL STORAGE LEVEL
C     DISTRIBUTIONS.
C
      CALL ANTRAC(NYRS,NSEAS,HISMS,SEAMIS,ANMHIS,FLXM,FLSD,HISTOR,DURN)
C
C     SUBROUTINE OUTPUT- PRINTS SUMMARY OUTPUT FOR EACH ROUTING.
C
      CALL OUTPUT(NYRS,NSEAS,   DAT1,KIND,C,STR,SEAMIS,ANMHIS,DURN,HISTOR
     1,FLXM,FLSD,KEY,IOIL,ISIZE,XMTAR,SDTAR,XMDIR,SDDIR,NPAGE,ISKIP,
     2HISMS,0)
   73 IF(MSIM)7,7,10
C
C     GENERATED TRACE KEY
C
   10 KEY=1
      IF(IIRIG)17,17,18
   18 IPAT=IPAT
C
C     SETTING INITIAL FLOW FOR GENERATOR.
C
      IF(ISTRUT-2)19,20,19
   20 YSAV=YSTART
      GO TO 17
```

D 5

```
19    YSAV1=YSTART
17    IKT=IRPAT
C
C     BEGIN ROUTING OF OPERATIONAL TRACE.
C
      DO 11 IY=1,NSIM
      IY=IY
C
C     SUBROUTINE GENFLO- COMPUTES ONE YEAR OF GENERATED TRACE.
C
      CALL GENFLO(FLOW,NSEAS,ISTRUT,IDIST,XM,SD,COR,REG,SE,WILSON,A11,
     1G11,B11,IRPAT,YSAV,YSAV1,YY,NSIM,IY)
C
C     SUBROUTINE SETUP- COMPUTES SEASONAL INFLOWS TO DAMSITE, DIVERSIONS
C     UNREGULATED FLOWS BETWEEN DAM AND TARGET POINT, AND TARGETS.
C
      CALL SETUP(FLOWIS,COFUNR,FLOW,XMTAR,SDTAR,XMDIR,SDDIR,NSEAS,
     1UNREG,TARGET,DIV,KEY,IY,IRPAT)
C
C     SUBROUTINE ROUTE- PERFORMS ROUTING, ONE YEAR AT A TIME.
C     RETURNS STORAGE VOLUMES, MISSES, FLOWS PAST TARGET POINT.
C
      CALL ROUTE(FLOW,UNREG,TARGET,DIV,C,ST,RFLA,RFLB,RFLC,XMISS,STVOL,
     1NSEAS,IOPT)
C
C     SUBROUTINE PROCES- COMPUTES SUMMING STATISTICS OF STORAGE VOLUMES,
C     ONE- SEASONAL MISSES, AND FLOWS PAST TARGET POINT.
C
      CALL PROCES(FLOW,XMISS,STVOL,C,NSEAS,HISMIS,HISMS,ANNMIS,SEAMIS,
     1ANUMIS,FLXM,FLSD,HISTOR,IY,OUTIAP,NSIM)
C
C     SUBROUTINE FAILUR- COMPUTES FAILURE DURATIONS OF UP TO 36 SEASONS.
C
11    CALL FAILUR(DURN,XMISS,IFLAG,SAVE,NSEAS,IY)
C
C     END ROUTING OF OPERATIONAL TRACE.
C
C
C     SUBROUTINE ANTRAC -COMPUTES STATISTICS OF ONE-SEASONAL FAILURES,
C     ANNUAL FAILURES, DURATION FAILURES, AND SEASONAL STORAGE LEVEL
C     DISTRIBUTIONS.
C
      CALL ANTRAC(NSIM,NSEAS,HISMS,SEAMIS,ANUMIS,FLXM,FLSD,HISTOR,DURN)
C
C     SUBROUTINE OUTPUT- PRINTS SUMMARY OUTPUT FOR EACH ROUTING.
C
      CALL OUTPUT(NSIM,NSEAS,  DAT1,KIND,C,STR,SEAMIS,ANUMIS,DURN,HISTOR
     1,FLXM,FLSD,KEY,IDIL,ISIZE,XMTAR,SDTAR,XMDIR,SDDIR,NPAGE,ISKIP,
     2HISMS,IKT)
      IHIST=0
```

D 6

```
C
C     USING MAXIMUM OF 100 YRS OF GENERATED TRACE TO COMPUTE STATISTICS.
C
      NX=MINO(100,NSIM)
      IF(ISKIP(13))21,21,7
C
C     COMPUTE STATISTICS OF GENERATED FLOWS FOR DISPLAY.
C
21    CALL STAT(YY,NN,NSEAS,0,0,0,XM,SD,COR,REG,SE,A11,B11,BIL,WILSON,
     1IDIST, DAT1 ,NPAGE,0,0)
7     CONTINUE
      GO TO 2
99    STOP
      END
      SUBROUTINE READ(FLOHIS,NYRS,NSEAS,DAR,COEUNR,ISTRUT,IPARM,IDIST,XM
     1,SD,WILSON,COR,REG,SE,A11,B11,BIL,NPAGE,IFIRST)
      DIMENSION SITE(18),FLOHIS(100,12),XM(12),SD(12),SK(12),COR(12),
     1SE(12),DAR(12),COEUNR(12),WILSON(12),REG(12)
C
C     FLOHIS- HISTORICAL FLOWS
C
C
C     NYRS- YEARS OF HISTORICAL FLOW
C
C
C     NSEAS- NUMBER OF SEASONS
C
C
C     DAR- SEASONAL DRAINAGE AREA COEFS. TRANSLATES FLOW AT GAING STATIO
C     TO INFLOWS AT DAMSITE.
C
C
C     COEUNR- SEASONAL COEF. FOR COMPUTING UNREGULATED FLOW(BETWEEN DAM
C     AND USE POINT) FROM INFLOWS AT DAMSITE.
C
C
C     ISTRUT- GENERATING MODEL. 1-CYCLICAL. 2.- RESIDUAL. 3.- NOT CODED.
C
C
C     IPARM- FLOW GENERATING MODEL PARAMETER KEY(0- COMPUTES PARAMETERS
C     FROM RAW INPUT DATA. 1.- PARAMETERS ARE INPUTED.
C
C     IDIST- TRANSFORM DISTRIBUTION KEY- 0- NO TRANSFORM. 2. LOG10.
C     3- SQRT. 4- GAMMA.
C
C
C     XM- SEASONAL MEANS FOR FLOW GENERATOR.
C
      CONTINUE
C
```

```
C       SD- SEASONAL STD. DEVNS. FOR FLOW GENERATOR.
C
C
C       WILSON- SEASONAL TRANSFORM FOR GAMMA DISTRIBUTED FLOWS.
C       COMPUTED INTERNALLY
C
C
C       COR- SEASONAL LAG1 CORRELATIONS FOR FLOW GENERATOR.
C
C
C       R.G- SEASONAL REGRESSION COEF. FOR FLOW GENERATOR.
C
C
C       SE- SEASONAL STD.ERR.EST. FOR FLOW GENERATOR.
C
C
C       A11- RESIDUAL MODEL Y(=A11*Y(I-1) + B11*E  CORRELATION OF RESIDUAL
C
C       B11- ERROR TERM FOR RESIDUAL MODEL.
C
C       WIL- GAMMA TRANSFORM FOR RESIDUAL MODEL.
C
C       NPAGE- PAGE COUNTER
C
C
C       IFIRST- 1ST CALENDER MONTH OF INPUT FLOW DATA OR OF INPUT PARM.
C
        READ(5,1)SITE
  1     FORMAT(18A4)
        WRITE(6,2)SITE
  2     FORMAT(1H0,14HTITLE OF STUDY,10X,18A4)
        READ(5,3)NYRS,NSEAS,IYEAR,IFIRST,ISTRUT,IPARM,IDIST
  3     FORMAT(10I5)
        DO 4 IY=1,NYRS
  4     READ(5,5)(FLOHIS(IY,ISEAS),ISEAS=1,NSEAS)
        READ(5,5)(DAR(ISEAS),ISEAS=1,NSEAS)
        READ(5,5)(COEUNR(ISEAS),ISEAS=1,NSEAS)
  5     FORMAT(12F6.0)
        DO 60 IY=1,NYRS
        DO 60 ISEAS=1,NSEAS
  60    FLOHIS(IY,ISEAS)=FLOHIS(IY,ISEAS)*DAR(ISEAS)
        IF(ISTRUT)52,52,53
  52    ISTRUT=1
  53    CONTINUE
        IF(IPARM)6,6,7
  7     GO TO (8,9,10),ISTRUT
  8     READ(5,5)(XM(ISEAS),ISEAS=1,NSEAS)
        READ(5,5)(SD(ISEAS),ISEAS=1,NSEAS)
        READ(5,5)(SK(ISEAS),ISEAS=1,NSEAS)
        READ(5,5)(COR(ISEAS),ISEAS=1,NSEAS)
```

```
      DO 11 ISEAS=1,NSEAS
      IF(IDIST-4)50,51,51
51    WILSON(ISEAS)=SK(ISEAS)*(1.0-COR(ISEAS)**3)/(SQRT(1.0-COR(ISEAS)**
     12)**3)
50    IF(ISEAS-1)40,40,41
40    REG(1)=COR(1)*SD(1)/SD(NSEAS)
      GO TO 11
41    REG(ISEAS)=COR(ISEAS)*SD(ISEAS)/SD(ISEAS-1)
11    SE(ISEAS)=SD(ISEAS)*SQRT(1-COR(ISEAS)**2)
      GO TO 26
9     READ(5,5)(XM(ISEAS),ISEAS=1,NSEAS)
      READ(5,5)(SD(ISEAS),ISEAS=1,NSEAS)
      READ(5,5)A11,B11,G11
      IF(IDIST-4)26,26,27
27    WIL=G11*(1.0-A11**3)/(SQRT(1.0-A11 **2)**3)
      GO TO 26
10    CONTINUE
6     WRITE(6,12)
12    FORMAT(1H04HYEAR,10X,17HHISTORICAL RECORD,10X,7HSEASONS//)
      IYEAR=IYEAR-1
      DO 13 IY=1,NYRS
      IYEAR=IYEAR+1
13    WRITE(6,14)IYEAR,(FLOWS(IY,ISEAS),ISEAS=1,NSEAS)
14    FORMAT(1H ,I4,5X,12F9.0)
26    WRITE(6,15)(DAR(ISEAS),ISEAS=1,NSEAS)
15    FORMAT(1H0H0HSEASONAL COEFS. FOR TRANSLATING FLOWS AT GAGING STATI
     10N TO INFLOWS AT THE DAMSITE/1H012F10.3)
      WRITE(6,16)(CUEUMM(ISEAS),ISEAS=1,NSEAS)
16    FORMAT(1H0H0HSEASONAL COEF. THAT SCALE THE INFLOWS AT DAMSITE TO U
     1NREGULATED LOCAL INFLOWS AT TEST SITE/1H012F10.3)
      IF(IPARAM)17,17,18
18    WRITE(6,25)
25    FORMAT(1H043HPARAMETER INPUT TO STREAM SIMULATION OPTION//)
      GO TO (19,20,21),ISTROT
19    WRITE(6,22)IDIST,(XM(ISEAS),ISEAS=1,NSEAS),(SD(ISEAS),ISEAS=1,
     1NSEAS),(SK(ISEAS),ISEAS=1,NSEAS),(COR(ISEAS),ISEAS=1,NSEAS)
22    FORMAT(1H035HCYCLICAL MODEL, DISTRIBUTION OPTION,I10//1H04HMEAN,
     112F10.3/1H04HS.D.,12F10.3/1H04HSKEW,12F10.3/1H04HCOR.,12F10.3)
      GO TO 17
20    WRITE(6,23)IDIST,(XM(ISEAS),ISEAS=1,NSEAS),(SD(ISEAS),ISEAS=1,
     1NSEAS),A11,B11,G11
23    FORMAT(1H050HTIME INVARIANT RESIDUAL MODEL, DISTRIBUTION OPTION,I10
     1//1H04HMEAN,12F10.3/1H04HS.D.12F10.3/1H04HA11 ,F10.3/1H04HB11 ,F10
     1.3/1H04HSKEW,F10.3)
      GO TO 17
21    WRITE(6,24)
24    FORMAT(1H0 9HPUG INPUT)
17    RETURN
      END
C
```

```
      SUBROUTINE STAT(FLOHIS,NYRS,NSEAS,IDIST,ISTRUT,IPARM,XM,SD,COR,REG
     1,SE,A11,B11,W1L,WILSON,IHIST,DAT1,NPAGE,YSTART)
      DIMENSION LHIST(14,20),FMAX(12),INDEX(20),FLOHIS(100,12),PARMEN(
     112,3),PARSD(12,3),PARSK(12,3),PARCOR(12,3),XM(12),SD(12),
     1COR(12),SF(12),YR(100),SUM(4,12),FLO(100,12),TSUM(3),RES(2,3)
     2,WILSUM(12),REG(12),DATDIS(3),DAT1(12)
      DATA DATDIS/4HNO  ,4HLOG ,4HSQRT/
C
C     OPERATIONS FOR SUBROUTINE STAT
C
C     1. COMPUTES SEASONAL,GRAND,AND YEARLY STATISTICS FOR RAW HISTORICA
C     DATA (INCLUDES HISTOGRAMS)
C
C     2. COMPUTES SEASONAL MOMENTS AND LAG CORRELATIONS FOR LOG10 AND
C     SQRT TRANSFORMS.
C
C     3. COMPUTES T-DIAGNOSTICS FOR ALL THREE TRANSFORMS.
C     IF THE RESIDUAL MODEL IS SPECIFIED, THE SKEWNESS IS COMPUTED FOR
C     THE ENTIRE TRACE.
C     FOR THE CYCLICAL MODEL THE OVERALL SKEWNESS IS WEIGHTED BY THE
C     MONTHLY MEANS.
C
C     4. FINDS LOWEST T, COMPARES TO 1.65 . IF GREATER THEN THE WILSON
C     HILFERTY TRANSFORM IS COMPUTED.
C
C     5. IN OPTION, THE STATISTICS OF THE GENERATED TRACE ARE COMPUTED A
C     DISPLAYED.
C
      DO 1 I=1,20
      DO 1 JSEAS=1,NSEAS
      FMAX(JSEAS)=0.0
      LHIST(JSEAS,I)=0
      LHIST(13,I)=0
    1 LHIST(14,I)=0
      DO 2 I=1,20
    2 INDEX(I)=I
      AMNMN=0.0
      SDMN=0.0
      SKMN=0.0
      FMAXAL=0.0
      FMAXYR=0.0
      FNSEAS=NSEAS
      FNY=NYRS
      FNM=FNSEAS*NYRS
      XMOYR=0.0
      SYR=0.0
      SDYR=0.0
      SKYR=0.0
      DO 3 IY=1,NYRS
      DO 3 ISEAS=1,NSEAS
```

```
C
C     CONSTRAINING ZERO FLOWS TO 0.01
C
    3 FLO(IY,ISEAS)=AMAX1(0.1,FLOHIS(IY,ISEAS))
      KEY=1
C
C     COMPUTES MOMENTS OF RAW DATA (NO TRANSFORM) FOR DISPLAY.
C
      CALL SEAMOM(NYRS,NSEAS,FLO,PARMEN,PARSD,PARSK,PARCOR,KEY,CROSEA)
      DO 4 IY=1,NYRS
      YR(IY)=0.0
C
C     GRAND MOMENTS
C
C
      DO 5 ISEAS=1,NSEAS
      AMOM=AMOM+FLOHIS(IY,ISEAS)
      SDMOM=SDMOM+FLOHIS(IY,ISEAS)**2
      SKMOM=SKMOM+FLOHIS(IY,ISEAS)**3
      FMAX(ISEAS)=AMAX1(FMAX(ISEAS),FLOHIS(IY,ISEAS))
    5 YR(IY)=YR(IY)+FLOHIS(IY,ISEAS)
C
C     YEARLY MOMENTS
C
      AYR=AYR+YR(IY)
      SDYR=SDYR+YR(IY)**2
      SKYR=SKYR+YR(IY)**3
    4 FMAXYR=AMAX1(FMAXYR,YR(IY))
      DO 6 ISEAS=1,NSEAS
    6 FMAXAL=AMAX1(FMAXAL,FMAX(ISEAS))
      DO 7 IY=1,NYRS
      IF(IY-1)8,8,9
C
C     YEARLY RAW CROSS-PRD SUM LAG CORR.
C
    9 CROYR=CROYR+YR(IY)*YR(IY-1)
      GO TO 7
    8 CROYR=CROYR+YR(IY)*YR(NYRS)
    7 CONTINUE
      GRD10=10
      GRD100=100
C
C     HISTOGRAM ANALYSIS
C
      DO 10 IY=1,NYRS
      XI=YR(IY)
      CALL HIST(GRD10,XI,FMAXYR,N)
      LHIST(14,N+10)=LHIST(14,N+10)+1
      IF(N-1)11,11,12
   11 CALL HIST(GRD100,XI,FMAXYR,N)
```

D 11

```
      LHIST(14,N)=LHIST(14,N)+1
   12 DO 10 ISEAS=1,NSEAS
      XI=FLOHIS(IY,ISEAS)
      CALL HIST(GRD10,XI,FMAXAL,N)
      LHIST(13,N+10)=LHIST(13,N+10)+1
      IF(N-1)13,13,14
C
C     SPLITTING LOWER 10TH INTO 100THS.
C
   13 CALL HIST(GRD100,XI,FMAXAL,N)
      LHIST(13,N)=LHIST(13,N)+1
   14 XMAX=FMAX(ISEAS)
      CALL HIST(GRD10,XI,XMAX,N)
      LHIST(ISEAS,N+10)=LHIST(ISEAS,N+10)+1
      IF(N-1)15,15,10
   15 CALL HIST(GRD100,XI,XMAX,N)
      LHIST(ISEAS,N)=LHIST(ISEAS,N)+1
   10 CONTINUE
      SDM=SDMON
C
C     COMPUTES MEAN AND STD. DEVN.
C
      CALL XMARSD(AMON,SDM,SDMON   ,FNOB)
C
C     COMPUTES SKEW
C
      CALL XSKEW(SKMON,SDM,SDMON,AMON,FNOB)
      SDY=SDYR
      CALL XMARSD(AYR,SDY,SDYR,FNY)
      CALL XSKEW(SKYR,SDY,SDYR,AYR,FNY)
      AMO=AMON
      SDMO=SDMON
      AY=AYR
      SDY=SDYR
C
C     COMPUTES CORRELATION
C
      CALL XCOR(CROSEA,AMIN,AMO,SDMON,SDMO,FNOB)
      CALL XCOR(CROYR,AYR,AY,SDYR,SDY,FNY)
      CALL PAGE(NPAGE)
C
C     PRINTS STATISTICS
C
      CALL PRINT(NYRS,NSEAS,PARMEN,PARSD,PARSK,AMON,SDMON,SKMON,AYR,SDYR
     1,SKYR,PARCOR,CROSEA,CROYR,LHIST,INDEX, DAT1 ,FMAX,FMAXAL,FMAXYR,
     1IHIST)
C
C     STARTING FLOW FOR FLOW GENERATOR
C
      YSTART=PARMEN(NSEAS,1)
```

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```
      IF(IHIST)70,70,54
C
C     STD. ERR. OF  SKEW - SEE KENDALL
C
54    SESK=SQRT((6.0*(FNY -2.0))/((FNY +1.0)*(FNY +3.0)))
C
C     CYCLICAL MODEL TRANSFORM DIAGNOSTIC ANALYSIS.
C
C
C     COMPUTING LOG10 AND SORT SEASONAL STATISTICS.
C
      DO 21 KEY=2,3
      DO 22 IY=1,NYRS
      DO 22 ISEAS=1,NSEAS
      X=AMAX1(0.1,FLOHIS(IY,ISEAS))
C
C     COMPUTES TRANSFORM
C
      CALL TRANS(X,KEY)
22    FLO(IY,ISEAS)=X
      CALL SEAMIN(NYRS,NSEAS,FLO,PARMEN,PARSD,PARSK,PARCOR,KEY,CROSEA)
21    CONTINUE
      IF(ISTRUT-2)18,24,70
C
C     T-DIAGNOSTIC
C
18    DO 25 I=1,3
25    TSUM(I)=0.0
      DO 26 K=1,3
      TSUMXM=0.0
      DO 27 ISEAS=1,NSEAS
C
C     WEIGHTING SKEWNESS BY SEASONAL MEANS.
C
      TSUM(K)=TSUM(K)+ABS(PARMEN(ISEAS,K)*PARSK(ISEAS,K))
27    TSUMXM=TSUMXM+PARMEN(ISEAS,K)
      TSUM(K)=TSUM(K)/TSUMXM
C
C     TSUM CONTAINS THREE TS
C
26    TSUM(K)=TSUM(K)/SESK
      GO TO 28
C
C     RESIDUAL MODEL TRANSFORM DIAGNOSTIC ANALYSIS
C
24    DO 30 KK=1,3
      RES(1,KK)=0.0
      RES(2,KK)=0.0
      DO 30 IY=1,NYRS
      DO 30 ISEAS=1,NSEAS
```

```
      X=AMAX1(0.1,FLOHIS(IY,ISFAS))
      CALL TRANS(X,KK)
C
C     STANDARDIZING
C
      X=(X-PARMEN(ISEAS,KK))/PARSD(ISEAS,KK)
C
C     COMPUTING SKEWNESS
C
      RES(1,KK)=RES(1,KK)+X**3
C
C     COMPUTING CORRELATION OF ENTIRE TRACE OF RESIDUALS.
C
      IF(IY-1)31,31,32
31    IF(ISFAS-1)35,35,33
35    YSAVE=X
      GO TO 30
32    IF(IY-NYRS)33,34,34
34    IF(ISFAS-NSFAS)33,36,36
33    RES(2,KK)=Y*X + RES(2,KK)
      Y=X
      GO TO 30
36    RES(2,KK)=YSAVE*X +RES(2,KK)
30    CONTINUE
      SESK=SQRT((6.0*(FNOB-2.0))/((FNOB+1.0)*(FNOB+3.0)))
      DO 37 KK=1,3
      RES(1,KK)=RES(1,KK)/FNOB
      RES(2,KK)=RES(2,KK)/FNOB
37    TSUM (KK)=RES(1,KK)/SESK
C
C     FINDING TRANSFORM THAT RENDERED DATA CLOSEST TO NORMAL.
C
28    FZ=20.0
      DO 39 KZ=1,3
      IF(TSUM(KZ)-FZ)40,40,39
40    FZ=TSUM (KZ)
      IDIST=KZ
39    CONTINUE
      GAMMIN=1.65
      IF(FZ-GAMMIN)41,41,42
C
C     GAMMA IS CHOSEN.
C
42    IDIST=4
41    DO 46 ISEAS=1,NSEAS
      KFY=IDIST
      IF(IDIST-4)47,48,48
48    KFY=1
C
C     COMPUTING WILSON TRANSFORM.
```

```
C
      IF(ISTRUT-2)71,47,47
71    WILSIM(ISEAS)=PARSK(ISEAS,KEY)*(1.0-PARCOR(ISEAS,KEY)**3)/
     1(SQRT(1.0-PARCOR(ISEAS,KEY)**2)**3)
C
C     BLOCKING CHOSEN MOMENTS INTO XM,SD,COR,REG, USED IN GENFLO
C
47    XM(ISEAS)=PARMEN(ISEAS,KEY)
      SD(ISEAS)=PARSD(ISEAS,KEY)
      COR(ISEAS)=PARCOR(ISEAS,KEY)
46    SE(ISEAS)=SD(ISEAS)*SQRT(1.0-COR(ISEAS)**2)
      DO 55 ISEAS=1,NSEAS
      IF(ISEAS-1)52,52,53
52    REG(1)=COR(1)*SD(1)/SD(NSEAS)
      GO TO 55
53    REG(ISEAS)=COR(ISEAS)*SD(ISEAS)/SD(ISEAS-1)
55    CONTINUE
      IF(ISTRUT-2)20,50,50
50    A11=RES(2,KEY)
      B11=SQRT(1.0-A11**2)
      IF(IDIST-4)20,51,51
51    WIL=RES(1,KEY)*(1.0-RES(2,KEY)**3)/(SQRT(1.0-RES(2,KEY)**2)**3)
20    CALL PAGE(NPAGE)
      WRITE(6,61)(SUM(I),I=1,3)
61    FORMAT(1H036HT - DIAGNOSTICS, T = SKEW/S.E.(SKEW)/1H012HNO TRANSFO
     1RM,2X,F10.3,2X,16HLOG 10 TRANSFORM,2X,F10.3,2X,14HSQRT TRANSFORM,
     22X,F10.3)
      IF(IDIST-4)62,63,63
62    WRITE(6,65)DATDIS(IDIST)
      GO TO 70
65    FORMAT(1H028HMINIMUM SKEWNESS OCCURS WHEN,2X,A4,2X,16HTRANSFORM IS
     1 USED)
63    WRITE(6,66)
66    FORMAT(1H078HGAMMA DISTRIBUTED FLOWS WILL BE GENERATED USING WILSO
     1N-HILFERTY TRANSFORMATION)
70    RETURN
      END
C
      SUBROUTINE SEAMOM( NY ,NSEAS,FLO,PARMEN,PARSD,PARSK,PARCOR,KEY,
     1CROSEA)
      DIMENSION SUM(4,12),PARMEN(12,3),PARSD(12,3),PARSK(12,3),PARCOR(
     112,3),FLO(100,12)
C
C     COMPUTES SEASONAL MEANS, STD. DEVN., SKEW,AND LAG1 CORR.
C
      CROSEA=0.0
      DO 1 I=1,4
      DO 1 JSEAS=1, NSEAS
1     SUM(I,JSEAS)=0.0
      DO 2 IY=1,NY
```

```
      KY=IY-1
      DO 2 ISEAS=1,NSEAS
      DO 3 K=1,3
    3 SUM(K,ISEAS)=SUM(K,ISEAS)+FLO(IY,ISEAS)**K
C
C     RAW SUM CROSS-PRD. SEASONAL LAG1 CORR.
C
      IF(ISEAS-1)4,4,5
    4 IF(IY-1)6,6,7
    6 SUM(4,1)=SUM(4,1)+FLO(1,1)*FLO(NY ,NSEAS)
      GO TO 2
    7 SUM(4,1)=SUM(4,1)+FLO(IY,1)*FLO(KY,NSEAS)
      GO TO 2
    5 SUM(4,ISEAS)=SUM(4,ISEAS)+FLO(IY,ISEAS)*FLO(IY,ISEAS-1)
    2 CONTINUE
      FNY=NY
      DO 8 ISEAS=1,NSEAS
      XX=SU (1,ISEAS)
      SUMSQ=SUM(2,ISEAS)
      SUMCUB=SUM(3,ISEAS)
      CALL XMARSD(XX,SUMSQ,SDEV,FNY)
      CALL XSKEW(SUMCUB,SUMSQ,SDEV,XX,FNY)
      PARMEN(ISEAS,KEY)=XX
      PARSD(ISEAS,KEY)=SDEV
      PARSK(ISEAS,KEY)=SUMCUB
C
C     RAW SUM CROSS-PRD. GRAND LAG 1 CORR.
C
      CROSFA=CROSFA+SUM(4,ISEAS)
    8 CONTINUE
      DO 9 ISEAS=1,NSEAS
      SUMCRX=SUM(4,ISEAS)
      IF(ISEAS-1)10,10,11
   10 PREVXM=PARMEN(NSEAS,KEY)
      PREVSD=PARSD(NSEAS,KEY)
      GO TO 12
   11 PREVXM=PARMEN(ISEAS-1,KEY)
      PREVSD=PARSD(ISEAS-1,KEY)
   12 XX=PARMEN(ISEAS,KEY)
      SDEV=PARSD(ISEAS,KEY)
      CALL XCOR(SUMCRX,XX,PREVXM,SDEV,PREVSD,FNY)
      PARCOR(ISEAS,KEY)=SUMCRX
    9 CONTINUE
      RETURN
      END
C
      SUBROUTINE PRINT(NYRS,NSEAS,PARXM,PARSD,PARSK,AMON,SDMON,SKMON,AYR
     1,SDYR,SKYR,PARCOR,CROSEA,CROYR,LHIST,INDEX, DAT1 ,FMAX,FMAXAL,
     2FMAXYR,IHIST)
      DIMENSION PA XM(12,3),PARSD(12,3),PARSK(12,3),LHIST(14,20),
```

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```
     1INDEX(20),FMAX(12),PARCOR(12,3),DATI(12)
C
C     PRINTS STATISTICS OF RAW DATA AND OPTIONALLY, GENERATED DATA.
C
      IF(IHIST)11,11,12
   11 WRITE(6,13)
   13 FORMAT(1H 69HSTATISTICS OF GENERATED FLOWS ,ONLY FIRST 100 YEARS O
     1F TRACE ARE USED)
   12 CONTINUE
      WRITE(6,1)NYRS
    1 FORMAT(1H023HSEASONAL STATISTICS      ,I5,2X,5HYEARS//1H 6HSEASON,
     14X,4HMEAN,10X,4HDEVN,10X,8HSKEWNESS,5X,10HCORR BACK ,5X,10HCOEFF. V
     1AR.///)
      DO 2 ISEAS=1,NSEAS
      CV=PARSD(ISEAS,1)/PARXM(ISEAS,1)
    2 WRITE(6,3)DATI(ISEAS),PARXM(ISEAS,1),PARSD(ISEAS,1),PARSK(ISEAS,1)
     1,PARCOR(ISEAS,1),CV
    3 FORMAT(1H A4,1X,5E14.4)
      NOB=NSEAS*NYRS
      CV=SDMON/AMON
      WRITE(6,4)AMON,SDMON,SKMON,CKOSEA,CV,NOB
    4 FORMAT(1H05X,5E14.4,10X,39HSTATISTICS FOR ALL SEASONS, OBSERVS. =
     1,I6)
      CV=SDYR/AYR
      WRITE(6,5)AYR,SDYR,SKYR,CKOYR,CV
    5 FORMAT (1H05X,5E14.4,10X,17HYEARLY STATISTICS)
      WRITE(6,6)NYRS,(INDEX(J),J=1,20)
    6 FORMAT(1H032HHISTOGRAMS OF SEASONAL FLOWS FOR ,2X,I4,2X,5HYEARS/
     11H 69HGRID SPACING FOR 1ST TEN COLUMNS IS 1/100TH OF MAXIMUM SEASO
     1NAL FLOW./1H 65HGRID SPACING FOR COLUMNS 11-20 IS 1/10TH OF MAXIMU
     1M SEASONAL FLOW//1H 6HSEASON,20X,36HPERCENTILES OF MAXIMUM SEASONA
     1L FLOW/1H 4X,10I6,1X,1H*,1X,I5,9I6///)
      DO 7 ISEAS=1,NSEAS
    7 WRITE(6,8)DATI(ISEAS),(LHIST(ISEAS,K),K=1,20)
    8 FORMAT(1H    A4,10I6,1X,1H*,1X,I5,9I6)
      WRITE(6,9)(LHIST(13,K),K=1,20),(LHIST(14,K),K=1,20)
    9 FORMAT(1H033HHISTOGRAM FOR ALL SEASONAL EVENTS//1H 4X,10I6,1X,1H*,
     11X,I5,9I6/1H020HHISTOGRAM OF ANNUALS//1H 4X,10I6,1X,1H*,1X,I5,9I6)
      WRITE(6,10)(FMAX(ISEAS),ISEAS=1,NSEAS),FMAXAL,FMAXYR
   10 FORMAT(1H033HRANGE FOR EACH SEASONAL HISTOGRAM/1H 6E20.4/1H 6E20.4
     1/1H 45HRANGE FOR TIME INVARIANT (SEASONAL) HISTOGRAM,E20.4,2X,
     227HRANGE FOR ANNUAL HISTOGRAM,2X,E20.4)
      RETURN
      END
C
      SUBROUTINE XMARSD(SUM,SUMSQ,SDEV,F)
C
C     COMPUTES MEAN AND STD. DEVN.
C
      IF(F-1.0)2,2,3
```

```
2     SDEV=0.0
      GO TO 1
3     IF(F-2.0)6,6,7
6     SUM=SUM/F
      SDEV=0.0
      GO TO 1
7     SUM=SUM/F
      SDEV=(SUMSQ-F*SUM**2)/(F-1.0)
      IF(SDEV)4,4,5
4     SDEV=0.0
      GO TO 1
5     SDEV=SQRT(SDEV)
1     RETURN
      END
C
      SUBROUTINE XSKEW(SUMCUB,SUMSQ,SDEV,SUM,F)
C
C     COMPUTES SKEWNESS
C
      IF(F-3.0)1,1,2
1     SUMCUB=0.0
      GO TO 3
2     SUMCUB=(SUMCUB-3.0*SUMSQ*SUM+2.0*F*SUM**3)/(F*SDEV**3)
3     RETURN
      END
C
      SUBROUTINE XCOR(SUMCRX,A1,A2,S1,S2,FY)
C
C     COMPUTES CORRELATION
C
      IF(FY-2.0)1,1,2
1     SUMCRX=0.0
      GO TO 3
2     SUMCRX=(SUMCRX-FY*A1*A2)/(FY-1.0)
      SUMCRX=SUMCRX/(S1*S2)
3     RETURN
      END
C
      SUBROUTINE HIST(GRIDNU,XI,XMAX,N)
C
C     USED FOR COMPUTING HISTOGRAMS
C
C
C     GRIDNU- NUMBER OF GRIDS
C
C
C     XI- FLOW VALUE
C
C
C     XMAX- RANGE
```

```
C
C
C     N- RETURN INDEX WHICH POSITIONS THE TALLYING MATRIX
C
      IF(XMAX)1,1,2
    1 N=1
      GO TO 3
    2 N=GRIDNU*X1/XMAX+1.0
      NGRID=GRIDNU
      N=MIN0(NGRID,N)
    3 RETURN
      END
      SUBROUTINE TRANS(X,KK)
C     COMPUTES DISTRIBUTION TRANSFORM
      IF(X)1,1,4
    4 GO TO (1,2,3),KK
    2 X=ALOG(X)/2.30259
      GO TO 1
    3 X=SQRT(X)
    1 RETURN
      END
C
      SUBROUTINE SETUP(FLOHIS,COEUNR,FLOW,XMTAR,SDTAR,XMDIR,SDDIR,NSEAS,
     1 UNREG,TARGET,DIV,KEY,IY,IRPAT)
      DIMENSION FLOHIS(100,12),COEUNR(12),FLOW(12),XMTAR(12),SDTAR(12),
     1XMDIR(12),SDDIR(12),UNREG(12),TARGET(12),DIV(12)
C
C     SETS UP FLOWS, TARGETS, AND DIVERSIONS A YEAR AT A TIME FOR ROUTE.
C
C
C     FLOHIS- HISTORICAL FLOWS
C
C
C     COEUNR- RATIOS SCALING FLOWS AT DAM TO UNREGULATED FLOWS
C
C
C     FLOW- ONE YEAR OF INFLOWS AT DAMSITE. USED IN SUBROUTINE ROUTE.
C
C
C     XMTAR- SEASONAL MEAN FLOW REQDS.
C
C
C     SDTAR- SEASONAL STD. DEVNS. OF FLOW REQDS.
C
C
C     XMDIR-SEASONAL MEAN DIVERSIONS AT DAMSITE ( IF NEGATIVE-ADDITION)
C
```

```
C
      CONTINUE
C     SDDIR- SEASONAL STD. DEVN. OF DIVERSIONS AT DAMSITE
C
C
C     NSEAS- NUMBER OF SEASONS PER YEAR
C
C
C     UNREG- ONE YEAR OF UNREGULATED FLOWS (BETWEEN DAM AND USE POINT)
C
C
C
C     TARGET- ONE YEAR OF TARGET FLOWS. USED IN ROUTE.
C
C
C     DIV- ONE YEAR OF SEASONAL DIVERSIONS . USED IN ROUTE.
C
C
C     IY- YEAR INDEX
C
C
C     IRPAT- RANDOM NUMBER GENERATOR TRIGGER
C
C
C     HISTORICAL OR GENERATED ROUTING FLAG
      IF(KEY)1,1,2
    1 IF(IY-1)3,3,4
C
C     HISTORICAL TRACE- NO NOISE ADDED TO TARGETS OR DIVERSIONS.
C
    3 DO 5 ISEAS=1,NSEAS
      TARGET(ISEAS)=XMTAR(ISEAS)
    5 DIV(ISEAS)=XMDIR(ISEAS)
    4 DO 6 ISEAS=1,NSEAS
    6 FLOW(ISEAS)=FLOHIS(IY,ISEAS)
      GO TO 8
C
C     FLOW TARGETS
C
    2 DO 7 ISEAS=1,NSEAS
      CALL CLT24(IRPAT,XXX)
      TARGET(ISEAS)=XMTAR(ISEAS)+XXX*SDTAR(ISEAS)
      TARGET(ISEAS)=AMAX1(TARGET(ISEAS),0.0)
      CALL CLT24(IRPAT,XXX)
C
C     DIVERSIONS
C
      IWASTE=0
      IF(XMDIR(ISEAS))10,10,11
   10 IWASTE=1
      XMDIR(ISEAS)=-XMDIR(ISEAS)
```

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```
      SDDIR(ISEAS)=-SDDIR(ISEAS)
   11 DIV(ISEAS)=XMDIR(ISEAS)+XXX*SDDIR(ISEAS)
      DIV(ISEAS)=AMAX1(DIV(ISEAS),0.0)
      IF(IWASTE)7,7,12
   12 XMDIR(ISEAS)=-XMDIR(ISEAS)
      SDDIR(ISEAS)=-SDDIR(ISEAS)
      DIV(ISEAS)=-DIV(ISEAS)
    7 CONTINUE
C
C     UNREGULATED FLOWS
C
    8 DO 9 ISEAS=1,NSEAS
    9 UNREG(ISEAS)=FLOW(ISEAS)*COEUNR(ISEAS)
      RETURN
      END
C
      SUBROUTINE CLT24(IX,X)
C
C     RANDOM NUMBER GENERATOR
C
      DIMENSION R(24)
      DO 1 I=1,24
      IY=IX*65539
      IF(IY) 2,3,3
    2 IY=IY+2147483647 +1
    3 YFL=IY
      IX=IY
    1 R(I)=YFL*.4656613E-9
      SUM=0.0
      DO 4 I=1,24
    4 SUM=SUM+R(I)
      X=(SUM/1.414211)-8.48526
      RETURN
      END
C
      SUBROUTINE GENFLO(FLOW,NSEAS,ISTRUT,IDIST,XM,SD,COR,REG,SE,WILSON,
     1A11,H11,WIL,INPAT,YSAV,YSAV1,YY,NSIM,IY)
      DIMENSION FLOW(12),XM(12),SD(12),COR(12),SE(12),WILSON(12),
     1REG(12),YY(100,12)
C
C     FLOW- ONE YEAR OF GENERATED INFLOWS AT DAMSITE.
C
C
C     NSEAS- NUMBER OF SEASONS PER YEAR
C
C
C     ISTRUT- STRUCTURAL FLOW OF MODEL. 0-CYCLICAL . 1. RESIDUAL
C
C
C     IDIST- DISTRIBUTION KEY
```

```
C
C
C      XM- SEASONAL MEANS
C
C
C      SD- SEASONAL STD. DEVNS.
C
C
C      COR- SEASONAL LAG1 CORRELATIONS
C
C
C      REG- SEASONAL REGRESSION COEFS.
C
C
C      SF- SEASONAL STD. ERR. EST.
C
C
C      WILSON- SEASONAL WILSON TRANSFORMS- IF GAMMA FLOWS ARE TO BE GENER
C
C
C      A11- RESIDUAL MODEL CORRELATION COEF.
       CONTINUE
C
C
C      B11- ERROR TERM IN RESIDUAL MODEL.
C
C
C      Y1L- WILSON TRANSFORM FOR RESIDUAL MODEL
C
C
C      INPAT- TRIGGER FOR RANDOM NUMBER GENERATOR.
C
C
C      YSAV- STARTING FLOW FOR FIRST YEAR AND ENDING FLOW FOR ITH YEAR.
C      CYCLICAL MODEL
C
C
C      YSAV1- TRIGGER AND YEARLY ENDING FLOW FOR RESIDUAL MODEL
C
C
C      YY- FIRST 100 YEARS OF GENERATED FLOW
C
C
C      IY- YEAR INDEX
C
       IGAM=0
       KRDIST=IDIST
       IF(KRDIST-4)1,2,2
2      KRDIST=1
       IGAM=1
```

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```
1     GO TO (3,4,5),ISTRUT
C
C     CYCLICAL MODEL
C
3     DO 6 ISEAS=1,NSEAS
C
C     COMPUTES RANDOM NUMBER
C
      CALL CLT24(IXPAT,XXX)
      IF(IGAM)7,7,8
C
C     RANDOM NUMBER DISTRIBUTED LIKE GAMMA
C
8     XXX=(2./WILSON(ISEAS))*(1.+WILSON(ISEAS)*XXX/6.0-WILSON(ISEAS)**2
     1/36.0)**3-2.0/WILSON(ISEAS)
7     Y=YSAV
C
C     TAKING OF DISTRIBUTION TRANSFORM OF (I-1)TH FLOW
C
      CALL TRANS(Y,KEDIST)
      IF(ISEAS-1)9,9,10
9     XMPREV=XM(NSEAS)
      GO TO 11
10    XMPREV=XM(ISEAS-1)
11    XMCUR=XM(ISEAS)
C
C     RECURSIVE RELATIONSHIP
C
      Y=XMCUR+REG(ISEAS)*(Y-XMPREV)+XXX*SE(ISEAS)
      Y=AMAX1(0.01,Y)
C
C     BACK DISTRIBUTION TRANSFORM
C
      CALL BACTAN(Y,KEDIST)
      FLOW(ISEAS)=Y
6     YSAV=Y
      GO TO 12
C
C     RESIDUAL MODEL
C
4     DO 13 ISEAS=1,NSEAS
      CALL CLT24(IXPAT,XXX)
      IF(IGAM)14,14,15
15    XXX=(2./WIL)*(1.0+WIL*XXX/6.0-WIL**2/36.0)**3-2.0/WIL
14    Y=A11*YSAV +B11*XXX
      YSAV=Y
C
C     TRANSFORM TO XY SPACE
C
      Y=XM(ISEAS)+Y*SD(ISEAS)
```

```
      Y=AMAX1(0.01,Y)
C
C     BACK DISTRIBUTION TRANSFORM
C
      CALL BACTAN(Y,KEDIST)
14    FLOW(ISEAS)=Y
      GO TO 12
5     CONTINUE
12    IF(IY-100)17,17,16
C
C     SAVING FLOWS FOR LATER STATISTICAL SANALYSIS
C
17    DO 18 ISEAS=1,NSEAS
18    YY(IY,ISEAS)=FLOW(ISEAS)
16    RETURN
      END
C
      SUBROUTINE BACTAN(Y,KEDIST)
C
C     COMPUTES BACK DISTRIBUTION TRANSFORM
C
      GO TO (1,2,3),KEDIST
2     Y=10**Y
      GO TO 1
3     Y=Y*Y
1     RETURN
      END
C
      SUBROUTINE ROUTE(FLOW,UNREG,TARGET,DIV,C,ST,RELA,RELB,RELC,XMISS,
     1STVOL,NSEAS,IOPT)
      DIMENSION FLOW(12),UNREG(12),TARGET(12),DIV(12),RELA(12),RELB(12),
     1RELC(12),XMISS(12),STVOL(12)
C
C     PERFORMS ROUTING ONE YEAR AT A TIME
C
C
C     FLOW- INFLOW INTO RESERVOIR- RETURNS WITH FLOWS PAST TEST POINT.
C
C
C     UNREG- LOCAL FLOWS BETWEEN DAM AND USE POINT.
C
C
C     TARGET- FLOW REQD. AT USE POINT.
C
C
C     DIV- DIVERSIONS AT DAMSITE.
C
C
C     C- CAPACITY OF RESERVOIR
C
```

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```
C
C     ST- STARTING STORAGE OF RESERVOIR
C
C
C     RELA- SEASONAL CONSTANT (A) IN EQUATION DRAFT= A + B*Q+ C*S
C
C
C     RELB- SEASONAL REGRESSION COEF.(B) IN ABOVE EQUATION.
      CONTINUE
C
C     RELC- SEASONAL REGRESSION COEF.(C) IN ABOVE EQUATION.
C
C     IF RELB(ISEAS) AND RELC(ISEAS) ARE ZERO AND RELA(ISEAS) IS NEGATIV
C     FRACTION , THEN THE RULE IS A PERCENTAGE OF CAPACITY CONSTRANT.
C
C
C     XMISS- FLOW REQD. MISSES FOR ONE- YEAR
C
C
C     STVOL- END OF SEASON STORAGE FOR EACH SEASON.
C
C
C     NSEAS- NUMBER OF SEASONS PER YEAR.
C
C
C     IOPT- RELEASE OPTIONS FOR RESERVOIRS.
C      1. RELEASE TO MEET FLOW TARGET.
C      2. OPERATE BY SEASONAL RULE CURVES.
C      3. OPERATE BY RULE CURVES WITH PRIVISIO OF OVERRIDING RULES TO
C     MEET DOWNSTREAM FLOW TARGET.
C
      DO 1 ISEAS=1,NSEAS
C
C     RESERVOIR SIZE EQUALS ZERO.
C
      IF(C)25,25,26
   25 AVAIL=FLOW(ISEAS)+UNREG(ISEAS)-DIV(ISEAS)
      AVAIL=AMAX1(0.0,AVAIL)
      FLOW(ISEAS)=AVAIL
      IF(AVAIL-TARGET(ISEAS))27,27,28
   27 XMISS(ISEAS)=TARGET(ISEAS)-AVAIL
      GO TO 1
   28 XMISS(ISEAS)=0.0
      GO TO 1
   26 CONTINUE
      [illegible]=0.0
      S[illegible]=0.0
      DRAFT=0.0
      AVAIL=FLOW(ISEAS)+ST
```

```
C
C     DIVERSION IS FROM THE TOTAL AVAILABLE ASSETS( IF NEGATIVE).
C     IF POSITIVE , IMPLIES RETURN FLOWS BELOW RESERVOIR.
C
      IF(DIV(ISFAS))30,30,31
   31 STREAM=DIV(ISFAS)
      GO TO 32
   30 AVAIL=AVAIL-DIV(ISFAS)
      AVAIL=AMAX1(AVAIL,0.0)
   32 IF(IOPT-2)2,3,3
C
C     SATISFYING CONTINUITY
C     RULES 1 AND 2 OR3 IF POOL LEVEL RULE IS OPERATIVE.
C
    2 IF(AVAIL-C)4,4,5
    4 SI=AVAIL
      GO TO 6
    5 DRAFT=AVAIL-C
      SI=C
    6 IF(STLEV)15,15,16
    3 IF(RELC(ISFAS))7,7,8
    7 IF(RELB(ISEAS))9,9,8
    9 IF(RELA(ISFAS))10,2,8
C
C     POOL LEVEL RULE.
C
   10 STLEV=1.0
      GO TO 2
C
C     COMPUTING FRACTION OF CAPACITY.
C
   16 STLEV=SI/C
      IF(STLEV+RELA(ISFAS))15,15,18
C
C     POOL LEVEL ABOVE DESIRED.
C
   18 STLEV=(STLEV+RELA(ISFAS))*C
      SI=SI-STLEV
      DRAFT=DRAFT+STLEV
      GO TO 15
C
C     GENERAL RULE CURVE.
C
    8 DRAFT=RELA(ISEAS)+RELB(ISEAS)*FLOW(ISFAS)+RELC(ISFAS)*ST
C
C     CONTINUITY CHECK- LOW SIDE
C
      DRAFT=AMAX1(DRAFT,0.0)
      ST=SI-DRAFT
      IF(ST-C)15,15,19
```

```
C
C     CONTINUITY CHECK- HIGH SIDE.
C
19    DRAFT=DRAFT+ST-C
      ST=C
C
C     OPTIONS 1 + 3 RELEASE MORE IF NEEDED.
C
15    STREAM=DRAFT+UNREG(ISEAS)+STREAM
      FLOW(ISEAS)=STREAM
      TAR=TARGET(ISEAS)-STREAM
      TAR=AMAX1(0.0,TAR)
      IF(IOPT-2)20,21,20
21    XMISS(ISEAS)=TAR
      STVOL(ISEAS)=ST
      GO TO 1
20    IF(TAR)29,29,22
22    IF(TAR-ST)24,23,23
23    FLOW(ISEAS)=FLOW(ISEAS)+ST
C
C     FLOW TARGET MISS
C
      XMISS(ISEAS)=TAR-ST
      ST=0.0
      STVOL(ISEAS)=ST
      GO TO 1
C
C     FLOW PAST TEST POINT.
C
24    FLOW(ISEAS)=FLOW(ISEAS)+TAR
      ST=ST-TAR
29    STVOL(ISEAS)=ST
      XMISS(ISEAS)=0.0
1     CONTINUE
      RETURN
      END
C
      SUBROUTINE PROCES(FLOW,XMISS,STVOL,C,NSEAS,HISMIS, HISMS,ANNMIS,
     1SEAMIS,ANUMIS,FLXM,FLSD,HISTOR,IY,OUTTAP,NY)
      DIMENSION FLOW(12),XMISS(12),STVOL(12),HISMIS(250,12),ANNMIS(250),
     1SEAMIS(12,5),ANUMIS(5),FLXM(12),FLSD(12),HISTOR(12,10), HISMS(13,
     110)
C
C     OPERATES ON RESPONSE DATA ONE YEAR AT A TIME.
C
C
C     FLOW- FLOWS PAST TEST SITE
C
C
C     XMISS- FLOW REQD. MISSES
```

```
C                                                                    1346
C     STVOL- END OF MONTH (SEASON) STORAGES                          1347
C                                                                    1348
C                                                                    1349
C     C- RESERVOIR CAPACITY                                          1350
C                                                                    1351
C                                                                    1352
C     HISMIS- SEASONAL MISSES SAVED FOR HISTOGRAM ANALYSIS.          1353
C     IF YEARS OF ROUTING IS LESS THAN 250 THEN THE OPERATION IS     1354
C     PERFORMED INTERNALLY.  IF GREATER THAN 250 THEN SCRATCH TAPE OR 1355
C     DISK IS USED.                                                  1356
C                                                                    1357
C                                                                    1358
C     HISMS- TALLYING HISTOGRAM MATRIX OF SEASONAL AND ANNUAL MISSES. 1359
C                                                                    1360
C                                                                    1361
C     ANMMIS- YEARLY MISSES. NOTE CONCERNING HISMIS IS ALSO APPLICABLE. 1362
C                                                                    1363
C                                                                    1364
C     SEAMIS- SEASONAL ONE-EVENT MISS STATISTICS. 1.-COUNT. 2. MEAN. 1365
C     3. STD. DEVN. 4. MAX. 5. MIN.                                  1366
C                                                                    1367
C                                                                    1368
C     ANMMIS- ANNUAL MISS STATISTICS. 1.COUNT. 2. MEAN. 3. STD. DEVN. 1369
C     4. MAX. 5. MIN.                                                1370
C                                                                    1371
C                                                                    1372
C     FLXM- SEASONAL MEANS PAST TEST POINT.                          1373
C                                                                    1374
      CONTINUE                                                       1375
C                                                                    1376
C     FLSD- SEASONAL STD. DEVN. PAST TEST POINT.                     1377
C                                                                    1378
C                                                                    1379
C     HISTOR- SEASONAL HISTOGRAMS OF STORAGE LEVELS.                 1380
C                                                                    1382
C     IY- YEAR INDEX                                                 1383
C                                                                    1384
C                                                                    1385
C     OUTTAP- FLAG TO STORE SEASONAL AND YEARLY MISSES ON SCRATCH DEVICE 1386
C                                                                    1387
C                                                                    1388
C     NY- YEARS OF ROUTING                                           1389
C                                                                    1390
C                                                                    1391
C                                                                    1392
C     INTIALIZING                                                    1393
C                                                                    1394
      IF(IY-1)1,1,2                                                  1395
    1 DO 3 ISEAS=1,NSEAS                                             1396
```

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```
      FLXM(ISEAS)=0.0
      FLSD(ISEAS)=0.0
      DO 3 I=1,10
      MISMS(ISEAS,I)=0.0
      MISMS(13,I)=0.0
    3 MISDUM(ISEAS,I)=0
      DO 4 I=1,4
      ANUMIS(I)=0.0
      DO 4 ISEAS=1,NSEAS
    4 SEAMIS(ISEAS,I)=0.0
      DO 5 ISEAS=1,NSEAS
    5 SEAMIS(ISEAS,5)=99999.
      ANUMIS(5)=99999.
      OUTTAP=0
      IF(NY-250)6,6,7
    2 OUTTAP=1
      REWIND2
      GO TO 2
    6 DO 8 J=1,NY
    8 ANNMIS(J)=0.0
    7 ANN=0.0
C
C     FLOWS PAST TEST POINT MOMENTS.
C
      DO 9 ISEAS=1,NSEAS
      FLXM(ISEAS)=FLXM(ISEAS)+FLOW(ISEAS)
      FLSD(ISEAS)=FLSD(ISEAS)+FLOW(ISEAS)**2
C
C     ONE-EVENT MISSES STATISTICS.
C
C
      IF(XMISS(ISEAS))9,9,11
   11 SEAMIS(ISEAS,1)=SEAMIS(ISEAS,1)+1.0
      SEAMIS(ISEAS,2)=SEAMIS(ISEAS,2)+XMISS(ISEAS)
      SEAMIS(ISEAS,3)=SEAMIS(ISEAS,3)+XMISS(ISEAS)**2
      IF(SEAMIS(ISEAS,4)-XMISS(ISEAS))12,12,13
   12 SEAMIS(ISEAS,4)=XMISS(ISEAS)
   13 IF(SEAMIS(ISEAS,5)-XMISS(ISEAS))9,9,10
   10 SEAMIS(ISEAS,5)=XMISS(ISEAS)
C
C     ANNUAL MISS STATISTICS
C
    9 ANN=ANN+XMISS(ISEAS)
      IF(ANN)14,14,16
   16 ANUMIS(1)=ANUMIS(1)+1.0
      ANUMIS(2)=ANUMIS(2)+ANN
      ANUMIS(3)=ANUMIS(3)+ANN**2
      IF(ANUMIS(4)-ANN)17,18,18
   17 ANUMIS(4)=ANN
   18 IF(ANUMIS(5)-ANN)19,19,15
```

```
15    ANUMIS(5)=ANN
14    IF(OUTTAP)19,19,20
20    WRITE(2)(XMISS(ISEAS),ISEAS=1,NSEAS),ANN
      IF(IY-NY)23,22,22
22    REWIND 2
23    CONTINUE
      GO TO 24
19    ANNMIS(IY)=ANN
C
C     SEASONAL STORAGE LEVEL HISTOGRAM ANALYSIS
C
      DO 25 ISEAS=1,NSEAS
25    HISMIS(IY,ISEAS)=XMISS(ISEAS)
24    IF(C)26,26,27
27    DO 28 ISEAS=1,NSEAS
      S=STVOL(ISEAS)
      GRD=10
      CALL HIST(GRD,S,C,N)
28    HISTOR(ISEAS,N)=HISTOR(ISEAS,N)+1.0
C
C     SEASONAL AND ANNUAL MISS  HISTOGRAM ANALYSIS.
C
26    IF(IY-NY)29,30,30
30    DO 33 JY=1,NY
      IL=JY
      IF(OUTTAP)31,31,32
32    IL=1
      READ(2)(HISMIS(IL,ISEAS),ISEAS=1,NSEAS),ANNMIS(IL)
31    X=ANNMIS(IL)
      IF(X)33,33,34
34    Y=ANUMIS(4)
      CALL HIST(GRD,X,Y,N)
      HISMS(13,N)=HISMS(13,N)+1.0
      DO 36 ISEAS=1,NSEAS
      X=HISMIS(IL,ISEAS)
      IF(X)36,36,35
35    Y=SEAMIS(ISEAS,4)
      CALL HIST(GRD,X,Y,N)
      HISMS(ISEAS,N)=HISMS(ISEAS,N)+1.0
36    CONTINUE
33    CONTINUE
      DO 37 ISEAS=1,NSEAS
      IF(SEAMIS(ISEAS,5)-99999.0)37,38,37
38    SEAMIS(ISEAS,5)=0.0
37    CONTINUE
      IF(ANUMIS(5)=99999.0)29,39,29
39    ANUMIS(5)=0.0
29    RETURN
      END
C
```

D 30

```
      SUBROUTINE FAILDR(DURN,XMISS,IFLAG,SAVF,NSEAS,IY)
      DIMENSION DURN(36,3),SPONGE(36),SAVE(36),REVERS(36),XMISS(12)
C
C     COMPUTES CONSECUTIVE FAILURE STATISTICS FOR UP TO 36 EVENTS.
C
C
C     DURATION FAILURE OF ITH LENGHT INCLUDES I- (I-1)TH PRECEEDING EVEN
C
C
      IF(IY-1)20,20,21
   20 DO 22 I=1,36
      REVERS(I)=0.0
      SAVE(I)=0.0
      SPONGE(I)=0.0
      DO 22 J=1,3
   22 DURN(I,J)=0.0
C
C     IFLAG- COUNTER OF CONSECUTIVE MISSES.
C
      IFLAG=0
   21 CONTINUE
      DO 1 ISEAS=1,NSEAS
C
C      XMISS- FAILURES FOR ONE- YEAR
C
      IF(XMISS(ISEAS))2,2,3
    3 IFLAG=IFLAG+1
      IF(IFLAG-37)4,10,10
    4 SAVE(IFLAG)=XMISS(ISEAS)
    5 DO 6 I=1,IFLAG
      J=IFLAG-I+1
    6 REVERS(I)=SAVE(J)
      DO 7 I=1,36
    7 SPONGE(I)=0.0
      DO 8 I=1,IFLAG
      DO 8 J=1,I
    8 SPONGE(I)=SPONGE(I)+REVERS(J)
C
C     DURN- COUNT, SUM, SUM SQUARE  OF CONSECUTIVE FAILURES
C
      DO 9 I=1,IFLAG
      DURN(I,1)=DURN(I,1)+1.0
      DURN(I,2)=DURN(I,2)+SPONGE(I)
    9 DURN(I,3)=DURN(I,3)+SPONGE(I)**2
      GO TO 1
    2 IFLAG=0
      DO 11 L=1,36
      SAVE(L)=0.0
   11 SPONGE(L)=0.0
      GO TO 1
C
```

```
C     DURATION LONGER THAN 36- NUMBER EXCEEDING 36 IS COUNTED AS (N+1)
C     36 EVENT FAILURES.
C
10    DO 12 I=2,36
      J=I-1
12    SAVE(J)=SAVE(I)
      SAVE(36)=XMISS(ISEAS)
      IFLAG=36
      GO TO 5
1     CONTINUE
      RETURN
      END
C
      SUBROUTINE AN TRAC(NY,NSEAS,HISMS,SEAMIS,ANUMIS,FLXM,FLSD,HISTOR,
     1DURN)
      DIMENSION HISMS(13,10),SEAMIS(12,5),ANUMIS(5),FLXM(12),FLSD(12),
     1HISTOR(12,10),DURN(36,3)
C
C     ABSTRACTS STATISTICS OF SUMMED RESPONSE DATA.
C
C
C     NY- YRS. OF ROUTING
C
C
C     NSEAS- NUMBER OF SEASONS PER YEAR
C
C
C     HISMS-HISTOGRAMS OF SEASONAL AND AND ANNUAL MISSES.
C
C
C     SEAMIS- PROB.,MOMENTS, MAX, AND MINS OF SEASONAL ONE-EVENT MISSES.
C
C
C     ANUMIS- PROB.,MOMENTS, MAX, AND MIN OF ANNUAL MISSES.
C
C
C     FLXM- SEASONAL MEAN FLOWS PAST TEST SITE.
C
C
C     FLSD- SEASONAL STD. DEVNS. OF FLOWS PAST TEST SITE.
C
C
C     HISTOR- SEASONAL HISOGRAMS OF STORAGE LEVELS.
C
C
C     DURN- CONSECUTIVE DURATION FAILURE MOMENTS.
C
      FY=NY
      FNUM=NY*NSEAS
C
```

D 32

```
C       SEASONAL MISS MOMENTS
C
        DO 1 ISEAS=1,NSEAS
        F=SEAMIS(ISEAS,1)
        SUM=SEAMIS(ISEAS,2)
        SUMSQ=SEAMIS(ISEAS,3)
        CALL XMARSD(SUM,SUMSQ,SDEV,F)
        SEAMIS(ISEAS,2)=SUM
        SEAMIS(ISEAS,3)=SDEV
        SUM=FLXM(ISEAS)
        SUMSQ=FLSD(ISEAS)
        CALL XMARSD(SUM,SUMSQ,SDEV,FY)
C
C       FLOW PAST TEST POINT MOMENTS.
C
        FLXM(ISEAS)=SUM
        FLSD(ISEAS)=SDEV
    1   CONTINUE
C
C       ANNUAL MISS MOMENTS
C
        F=ANUMIS(1)
        SUM=ANUMIS(2)
        SUMSQ=ANUMIS(3)
        CALL XMARSD(SUM,SUMSQ,SDEV,F)
        ANUMIS(2)=SUM
        ANUMIS(3)=SDEV
C
C       DURATION MISS MOMENTS
C
        DO 3 I=1,26
        I=I
        FI=I
        F=DURN(I,1)
        SUM=DURN(I,2)
        SUMSQ=DURN(I,3)
        CALL XMARSD(SUM,SUMSQ,SDEV,F)
        DURN(I,2)=SUM
        DURN(I,3)=SDEV
    3   DURN(I,1)=DURN(I,1)/(FNDR-FI+1.0)
C
C       STORAGE LEVEL PROBABILITIES
C
        DO 4 ISEAS=1,NSEAS
        DO 4 I=1,10
        HISTOR(ISEAS,I)=HISTOR(ISEAS,I)/FY
    4   CONTINUE
C
C       SEASONAL AND ANNUAL HISTOGRAM PROBABILITIES
C
```

D 33

```
      DO 5 IS=1,13
      YX=0.0
      IF(IS-13)6,7,7
    6 YZ=SEAMIS(IS,1)
   10 IF(YZ)5,5,8
    8 DO 9 I=1,10
      XY=HISMS(IS,I)/YZ
      YX=YX+XY
    9 HISMS(IS,I)=YX
      SEAMIS(IS,1)=SEAMIS(IS,1)/FY
      GO TO 5
    7 YZ=ANUMIS(1)
      ANUMIS(1)=ANUMIS(1)/FY
      GO TO 10
    5 CONTINUE
      RETURN
      END
C
      SUBROUTINE OUTPUT(NY,NSEAS, DAT1 ,KIND,C,STR,SEAMIS,ANUMIS,DURN,
     1HISTOR,FLXM,FLSD,KEY,IDIL,ISIZE,XMTAR,SDTAR,XMDIR,SDDIR,NEAGE,
     2ISKIP,HISMS,IRT)
      DIMENSION KIND(18),FLXM(12),FLSD(12),SEAMIS(12,5),ANUMIS(5),
     1DURN(36,3),HISTOR(12,10),XMTAR(12),SDTAR(12),XMDIR(12),SDDIR(12)
      DIMENSION SCRT(10),HISMS(13,10),ISKIP(15),DAT1(12),FMAX(12)
C
C     NY- YEARS OF ROUTING
C
C
C     NSEAS- NUMBER OF SEASONS
C
C
C     DAT1- FOR PRINTING PURPOSES
C
C
C     C- RESERVOIR CAPACITY
C
C
C     STR- STARTING STORAGE
C
C
C     SEAMIS- SEASONAL ONE-EVENT MISSES.- PROB.,MEAN,STD. DEVN.,MAX,MIN
C
C
C     ANUMIS- YEARLY MISSES- PROB., MEAN,STD.DEVN.,MAX,MIN
C
C
C     DURN- CONSECUTIVE MISSES- PROB.,MEAN,STD.DEVN.
C
C
C     HISTOR- SEASONAL STORAGE LEVEL HISTOGRAMS
```

D 34

```
C
C
C     FLXM- SEASONAL MEAN FLOWS PAST USE POINT
C
      CONTINUE
C
C     F. SD- SEASONAL STD. DEVN. FLOWS PAST TEST POINT
C
C
C     KEY- TYPE OF ROUTIN FLAG (HISTORICAL- SYNTHETIC)
C
C
C     IDIL- DILUTION VECTOR KEY
C
C
C     XMTAR-SEASONAL MEAN FLOW REQD.
C
C
C     SDTAR- SEASONAL STD. DEVN. FLOW REQD.
C
C
C     MPAGE- PAGE COUNTER
C
C
      CONTINUE
C     ISKIP- PRINT SUPPRESS
C
C
C      1. HISTORICAL ONE-SEASON MISSES
C      2. HISTORICAL ANNUAL MISSES
C      3. HISTORICAL DURATION MISSES
C      4A. HISTORICAL SEASONAL ONE-EVENT MISS HISTOGRAMS + ANNUAL
C         HISTOGRAM.  TABULAR FORM
C      4B.- SAME GRAPHIC
C      5A.-HISTORICAL SEASONAL HISTOGRAMS OF RESERVOIR LEVELS. TABULAR
C      5B.- SAME GRAPHIC
C      6. HISTOICAL MOMENTS OF FLOWS PAST USE POINT
C      7.-12. GENERATED ANALYSIS   DITTO 1.-6.
C      13. DISPLAY STATISTICS FOR TRACE OF GENERATED FLOWS.
C
C
C     NOTE- 1-PUNCH WILL SUPPRESS PRINTING FOR ALL ITEMS SAVE 4,5,8,9.
C     THESE ITEMS ARE OUTPUTED IN TWO FORMS. 1-PUNCH CAUSES TABULAR
C     FORM TO BE SUPPRESSED.  2-PUNCH CAUSES BOTH MODES TO BE SUPPRESSED
C
C     HISMS- HISTOGRAM OF SEASONAL AND ANNUAL MISSES.
C
C
C     IRT- RANDOM NUMBER TRIGGER FOR TRACE
C
```

D 35

```
      DO 1 I=1,12
    1 FMAX(I)=SEAMIS(I,4)
      FMAXYR=ANUMIS(4)
      CALL PAGE(NPAGE)
      KE=0
      KM=1
      IF(KEY)2,2,30
   30 KE=6
      KM=6
      GO TO 4
    2 WRITE(6,3)(KIND(I),I=1,18)
    3 FORMAT(1H 25HHISTORICAL RECORD ROUTING,10X,18A4)
      GO TO 5
    4 WRITE(6,6)(KIND(I),I=1,18),IRT
    6 FORMAT(1H 24HSYNTHETIC RECORD ROUTING,10X,18A4,5X,14HRANDOM TRIGGE
     1R,I4)
    5 WRITE(6,31)NY,NSEAS,ISIZE,C,STR,IDIL
   31 FORMAT(1H 16HYEARS OF ROUTING,1X,I4,3X,7HSEASONS,I4,2X,7HDAM TRY,
     12X,I4,2X,8HDAM SIZE,1X,F10.0,2X,16HSTARTING STORAGE,1X,F10.0,1X,
     2           12HDILUTION SET,2X,I4)
C
C     ONE-EVENT MISSES
C
      IF(ISKIP(KM))7,7,8
    7 WRITE(6,9)
    9 FORMAT(1H                            31HSTATISTICS OF ONE-SEASON MISS
     1ES/ 1H 6HSEASON,2X,9HDIL. REQD,2X,
     24HC.V.,5X,5HPROB.,8X,4HMEAN,8X,4HS.D.,8X,7HMAXIMUM,8X,7HMINIMUM//)
      DO 10 ISEAS=1,NSEAS
      IF(XMTAR(ISEAS))11,11,12
   11 CV=0.0
      GO TO 10
   12 CV=SDTAR(ISEAS)/XMTAR(ISEAS)
   10 WRITE(6,13)DATI(ISEAS),XMTAR(ISEAS),CV,(SEAMIS(ISEAS,I),I=1,5)
   13 FORMAT(1H A4,4X,F9.0,F6.1,F10.3,2F12.1,2F15.1)
C
C     ANNUAL MISSES
C
    8 IF(ISKIP(KE+2))14,14,15
   14 WRITE(6,16)(ANUMIS(I),I=1,5)
   16 FORMAT(1H017HANNUAL STATISTICS,2X,2F12.1,3F15.1)
C
C     DURATION STATISTICS
C
   15 IF(ISKIP(KE+3))17,17,18
   17 WRITE(6,19)
   19 FORMAT(1H042HSTATISITICS OF CONSECUTIVE SEASONAL MISSES,10X,
     18HDURATION,5X,5HPROB.,8X,4HMEAN,8X,4HS.D. )
      DO 20 I=1,36
   20 WRITE(6,21)I,(DURN(I,J),J=1,3)
```

```
21    FORMAT(1H 50X,I6,7X,F5.3,2F12.2)
C
C     HISTOGRAMS OF MISSES
C
18    IF(ISKIP(KE+4))22,22,23
22    CALL PAGE(NPAGE)
      WRITE(6,24)
24    FORMAT(1H059HACCUMULATIVE FREQUENCY DISTRIBUTIONS OF ONE - SEASON
     1MISSES/1H011IHELEMENTS IN FIRST ROW ARE ACCUMULATIVE PROBABILITIES
     1, ELEMENTS IN 2ND ROW ARE CORRESPONDING INTERMEDIATE RANGES//1H0
     16HSEASON)
      DO 25 ISEAS=1,NSEAS
      DO 26 I=1,10
      FI=I
26    SCRT(I)=(SFAMIS(ISEAS,4)/10.0)*FI
25    WRITE(6,27)DAT1(ISEAS),(HISMS(ISEAS,K),K=1,10),(SCRT(I),I=1,10)
27    FORMAT(1H0A4,2X,10F11.3/1H 6X,10F11.0)
      DO 28 I=1,10
      FI=I
28    SCRT(I)=(ANUMIS(4)/10.0)*FI
      WRITE(6,29)(HISMS(13,K),K=1,10),(SCRT(I),I=1,10)
29    FORMAT(1H029HDISTRIBUTION OF ANNUAL MISSES/1H 6X,10F11.3/1H 6X,
     110F11.0)
23    CALL PAGE(NPAGE)
C
C     HISTOGRAMS OF RESERVOIR STORAGE LEVELS
C
      IF(ISKIP(KE+ 1))39,39,40
39    IF(C)40,40,32
32    DO 33 I=1,10
      FI=I
33    SCRT(I)=10.0*FI
      WRITE(6,34)C,(SCRT(I),I=1,10)
34    FORMAT(1H012HDAM CAPACITY,2X,F10.3,2X,40HSEASONAL DISTRIBUTIONS OF
     1 STORAGE LEVELS/
     1                    1H 88HELEMENTS IN EACH ROW ARE THE PROBABILITIES AS
     1SOCIATED WITH PERCENTAGES OF CAPACITY SHOWN/1H06HSEASON,2X,5HEMPTY
     2,10F10.0,2X,4HFULL)
      DO 35 ISEAS=1,NSEAS
35    WRITE(6,36)DAT1(ISEAS),(HISTOR(ISEAS,K),K=1,10)
36    FORMAT(1H0A4,9X,10F10.3)
C
C     MOMENT OF FLOWS PAST USE POINT
C
40    IF(ISKIP(KE+6))37,37,38
37    WRITE(6,41)(FLXM(ISEAS),ISEAS=1,NSEAS),(FLSD(ISEAS),ISEAS=1,NSEAS)
41    FORMAT(1H055HMEANS AND STD. DEVNS. OF SEASONAL FLOWS PAST TEST POI
     1NT/1H04HMEAN, 12F10.1/1H 4HS.D.,12F10.1)
38    CONTINUE
C
```

```
C     SUBROUTINE OUTPLT- 1. PLOTS HISTOGRAMS OF SEASONAL AND ANNUAL
C     MISSES. 2. PLOTS RESERVOIR STORAGE LEVEL HISTOGRAMS.
C
      CALL OUTPLT(HISMS,HISTOR,NPAGE,EMAX,EMAXYR,C,KIND,DAT1,ISKIP,KEY)
      RETURN
      END
C
      SUBROUTINE OUTPLT(HISMS,HISTOR,NPAGE,EMAX,EMAXYR,C,KIND,DAT1,ISKIP
     1,KEY)
      DIMENSION HISMS (13,10),HISTOR(12,10),GRID(3000),X1(10),Y1(10),
     1Y2(10),Y3(10),Y4(10),Y5(10),Y6(10),FMAX(12),KIND(18),DAT1(12)
      DIMENSION IDAT(12),ISKIP(15)
      DO 1 I=1,12
      K=I
      IF(K-7)2,3,3
    3 IDAT(I)=K-6
      GO TO 1
    2 IDAT(I)=K
    1 CONTINUE
      IF(KEY)4,4,5
    4 KM=0
      GO TO 6
    5 KM=6
    6 IF(ISKIP(KM+4)-2)7,7,8
    7 CALL PAGE(NPAGE)
      IF(KEY)9,9,10
    9 WRITE(6,11)KIND
   11 FORMAT(1H 26HHISTORICAL RECORD ANALYSIS,10X,18A4/)
      GO TO 12
   10 WRITE(6,13)KIND
   13 FORMAT(1H 25HSYNTHETIC RECORD ANALYSIS,10X,18A4/)
   12 KE=0
   14 DO 15 I=1,10
      F=I
      X1(I)=F/10.0
      Y1(I)=HISMS (KE+1,I)
      Y2(I)=HISMS (KE+2,I)
      Y3(I)=HISMS (KE+3,I)
      Y4(I)=HISMS (KE+4,I)
      Y5(I)=HISMS (KE+5,I)
   15 Y6(I)=HISMS (KE+6,I)
      CALL PLOT2(GRID,1.0,0.0,1.0,0.0)
      N=KE+1
      M=KE+6
      DO 16 I=1,10
   16 X1(I)=X1(I)-0.01
      CALL PLOT3(:1:,X1,Y1,10)
      DO 17 I=1,10
   17 X1(I)=X1(I)-0.01
      CALL PLOT3(:2:,X1,Y2,10)
```

D 38

```
      DO 18 I=1,10
   18 X1(I)=X1(I)-0.01
      CALL PLOT3(:3:,X1,Y3,10)
      DO 19 I=1,10
   19 X1(I)=X1(I)-0.01
      CALL PLOT3(:4:,X1,Y4,10)
      DO 20 I=1,10
   20 X1(I)=X1(I)-0.01
      CALL PLOT3(:5:,X1,Y5,10)
      DO 21 I=1,10
   21 X1(I)=X1(I)-0.01
      CALL PLOT3(:6:,X1,Y6,10)
      IF(KE)22,22,23
   22 CALL PLOT 4(51,:ACCUM. PROB. SCALE, 1ST 6 SEASONS, ONE-EVENT MISSE
     1S:)
      GO TO 24
   23 CALL PLOT 4(51,:ACCUM. PROB. SCALE, 2ND 6 SEASONS, ONE-EVENT MISSE
     1S:)
   24 WRITE(6,25)
   25 FORMAT(1H026HPERCENTAGE OF MAXIMUM MISS)
      WRITE(6,26)(FMAX(I),I=N,M)
   26 FORMAT(1H023HMAXIMUM SEASONAL MISSES,6F14.0)
      WRITE(6,27)(IDAT(L),DAT1(L),L=N,M)
   27 FORMAT(1H 3HKEY,2X,8HSEASONS ,10X,6(4X,I2,1X,1H-,1X,A4,1H*))
      IF(KE)28,28,29
   28 KE=6
      CALL PAGE(NPAGE)
      GO TO 14
   29 CALL PAGE(NPAGE)
      DO 30 I=1,10
      F=I
      X1(I)=F/10.0
   30 Y1(I)=MISMS (13,I)
      CALL PLOT2(GRID,1.0,0.0,1.0,0.0)
      CALL PLOT3(:A:,X1,Y1,10)
      CALL PLOT4(39,:ACCUMULATIVE PROB. SCALE, ANNUAL MISSES:)
      WRITE(6,25)
      WRITE(6,31)FMAXYR
   31 FORMAT(1H019HMAXIMUM ANNUAL MISS,10X,F14.0)
    8 IF(ISKIP(K9+5)-2)32,32,33
   32 CALL PAGE(NPAGE)
      IF(KEY)34,34,35
   34 WRITE(6,11)KIND
      GO TO 36
   35 WRITE(6,13)KIND
   36 KE=0
   37 DO 38 I=1,10
      F=I
      X1(I)=F/10.0
      Y1(I)=HISTOR(KE+1,I)
```

```
      Y2(I)=HISTOR(KE+2,I)
      Y3(I)=HISTOR(KE+3,I)
      Y4(I)=HISTOR(KE+4,I)
      Y5(I)=HISTOR(KE+5,I)
38    Y6(I)=HISTOR(KE+6,I)
      CALL PLOT2(GRID, 1.0,0.0,1.0,0.0)
      DO 39 I=1,10
39    X1(I)=X1(I)-0.01
      CALL PLOT3(:1:,X1,Y1,10)
      DO 40 I=1,10
40    X1(I)=X1(I)-0.01
      CALL PLOT3(:2:,X1,Y2,10)
      DO 41 I=1,10
41    X1(I)=X1(I)-0.01
      CALL PLOT3(:3:,X1,Y3,10)
      DO 42 I=1,10
42    X1(I)=X1(I)-0.01
      CALL PLOT3(:4:,X1,Y4,10)
      DO 43 I=1,10
43    X1(I)=X1(I)-0.01
      CALL PLOT3(:5:,X1,Y5,10)
      DO 44 I=1,10
44    X1(I)=X1(I)-0.01
      CALL PLOT3(:6:,X1,Y6,10)
      IF(KE)45,45,46
45    CALL PLOT4(34,:PROBABILITY SCALE, 1ST SIX SEASONS:)
      GO TO 47
46    CALL PLOT4(34,:PROBABILITY SCALE, 2ND SIX SEASONS:)
47    WRITE(6,48)C
48    FORMAT(1H0032HPERCENTAGE OF RESERVOIR CAPACITY,10X,11HCAPACITY = ,
     1F14.0)
      N=KE+1
      M=KE+6
      WRITE(6,27)(IDAT(L),DAT1(L),L=N,M)
      IF(KE)49,49,33
49    KE=6
      CALL PAGE(NPAGE)
      GO TO 37
33    RETURN
      END
C
      SUBROUTINE FIRST(IFIRST,NSEAS,INDES)
C
C     ARRANGES ORDER OF MONTHS- PRINTING PURPOSES
C
      INDES=INDES-1+IFIRST
      INDES=INDES-(INDES/(NSEAS+1))*NSEAS
      RETURN
      END
      SUBROUTINE PAGE(N)
```

```
C
C     PAGE COUNTER
C
      NN=N+1
      WRITE(6,1)N
    1 FORMAT(1H1,16X,I4)
      RETURN
      END
      SUBROUTINE PRPLOT

      IMPLICIT  LOGICAL*1(W), LOGICAL*1(K)
      DIMENSION  NSCALE(5),ANNOS(26),X(1),Y(1)
      LOGICAL*1   VC      ,HC/:-:/,NC/:<:/,BL/: :/
     C         , HF/:F:/,HF1/:.:/,HF2/:,:/
      DATA VC/Z4F/
      LOGICAL*1  FOR1(19)/:(1XA1,F8.  ,1X121A1):/
     C          ,FOR2(15)/:(1XA1, 9X121A1):/
     C          ,FOR3(19)/:(1HOF  .  ,  F    .  ):/
      DATA KPLOT1 /.FALSE./, KPLOT2/.FALSE./
      DATA  KABSC,KORD,KRUTGL /3*.FALSE./
C
      ENTRY PLOT1(NSCALE,NHL,NSBH,NVL,NSBV)
      KPLOT1>.TRUE.
      KPLOT2>.FALSE.
  123 NH>IABS(NHL)
      NSH>IABS(NSBH)
      NV>IABS(NVL)
      NSV>IABS(NSBV)
      NSC>NSCALE(1)
      IF(NH*NSH*NV*NSV.NE.0) GO TO 128
      WRITE (6,14)
   14 FORMAT(15,:SOME PLOT1 ARG. ILLEGALLY 0:)
      KPLOT>.FALSE.
      RETURN
  128 KPLOT>.TRUE.
      IF(NV.LE.25) GO TO 126
      WRITE (6,12)
      KPLOT>.FALSE.
   12 FORMAT(15,:NO. OF VERTICAL LINES \25:)
      RETURN
  126 CONTINUE
      NV>NV-1
      NVP>NV<1
      NHH>NH*NSH
      NHHP>NHH<1
      NNV>NV*NSV
      NNVP>NNV<1
      NTAG>(NHHP*NNVP)
      IF(NNV.LE.120) GO TO 130
```

```
      KPLOT>.FALSE.
      WRITE (6,11)
11    FORMAT(T5,:WIDTH OF GRAPH \121:)
      RETURN
130   CONTINUE
      IF(NSCL.EQ.0) GO TO 70
      FSY>10.**NSCALE(2)
      FSX>10.**NSCALE(4)
      IY>MINO(IABS(NSCALE(3)),7)<1
      IX>MINO(IABS(NSCALE(5)),9)<1
      GO TO 75
70    FSY>1.
      FSX>1.
      IY>4
      IX>4
75    FOR1(10)>NOS(IY)
      NV>MINO(IX,NSV)-1
      NS>NA-MINO(NA,129-NOV)
      NB>11-NS<NA
      I1>NB/10
      I2>NB-I1*10
      FOR3(6)>NOS(I1<1)
      FOR3(7)>NOS(I2<1)
      FOR3(9)>NOS(NA<1)
      IF(NV.GT.0) GO TO 90
      DO 80 J>11,18
80    FOR3(J)>NE
      GO TO 100
90    I1>NV/10
      I2>NV-I1*10
      FOR3(11)>NOS(I1<1)
      FOR3(12)>NOS(I2<1)
      FOR3(13)>NF
      I1>NSV/100
      I2>NSV-I1*100
      I3>I2/10
      I3>I3-I2*10
      FOR3(14)>NOS(I1<1)
      FOR3(15)>NOS(I2<1)
      FOR3(16)>NOS(I3<1)
      FOR3(17)>NEI
      FOR3(18)>FOR3(9)
100   IF(KPLOT1) RETURN
      KPLOT1>.TRUE.
C
      ENTRY PLOT2(IMAGE,XMAX,XMIN,YMAX,YMIN)
      KPLOT2>.TRUE.
      IF(KPLOT1) GO TO 210
      NSCL>0
      NN>5
```

```
      NSH>10
      NV>10
      NSV>10
      GO TO 128
210   CONTINUE
      IF(.NOT.KPLOT)RETURN
      YMAX>YMAX
      DH>(YMAX-YMIN)/FLOAT (NDH)
      DV>(XMAX-XMIN)/FLOAT(NDV)
      DO 220 I>1,NVP
220   ABNOS(I)>(XMIN<FLOAT((I-1)*NSV)*DV)*FSX
      DO 225 I>1,NIMG
225   IMAGE(I)>BL
      DO 240 I>1,NDHP
      I2>I*NDVP
      I1>I2-NDV
      KHMOK>MOD(I-1,NSH).NE.0
      IF(KHMOK) GO TO 230
      DO 228 J>I1,I2
228   IMAGE(J)>HC
230   CONTINUE
      DO 240 J>I1,I2,NSV
      IF(KHMOK) GO TO 235
      IMAGE(J)>HC
      GO TO 240
235   IMAGE(J)>VC
240   CONTINUE
      XMIN1>XMIN-DV/2.
      YMIN1>YMIN-DH/2.
      RETURN
C
      ENTRY PLOT3(CH,X,Y,N3)
300   IF(KPLOT2) GO TO 312
301   WRITE (6,13)
13    FORMAT(I5,:PLOT2 MUST BE CALLED:)
312   CONTINUE
      IF(.NOT.KPLOT) RETURN
      IF(N3.GT.0) GO TO 314
      KPLOT>.FALSE.
      WRITE (6,15)
15    FORMAT(I5,:PLOT3, ARG2 = 0:)
      RETURN
314   DO 320 I>1,N3
      DUM1>(X(I)-XMIN1)/DV
      DUM2>(Y(I)-YMIN1)/DH
      IF(DUM1.LT.0..OR.DUM2.LT.0.) GO TO 320
      IF(DUM1.GE.NDVP.OR.DUM2.GE.NDHP) GO TO 320
      NX>1<INT(DUM1)
      NY>1<INT(DUM2)
315   J>(NDHP-NY)*NDVP<NX
```

```
      IMAGE(J)>CH
  320 CONTINUE
      RETURN
C
      ENTRY PLOT4(NL,LABEL)
      ENTRY FPLOT4(NL,LABEL)
      IF(.NOT.KPLOT) RETURN
      IF(.NOT.KPLOT2) GO TO 301
      DO 420 I>1,NOMP
      IF(I.EQ.NOMP.AND.KNOTGL) GO TO 420
      WL>BL
      IF(I.LE.NL) WL>LABEL(I)
      I2>I*NDVP
      I1>I2-NDV
      IF(MOD(I-1,NSF).EQ.0.AND..NOT.KORD) GO TO 410
      WRITE (6,FOR2) WL,(IMAGE(J),J>I1,I2)
      GO TO 420
  410 CONTINUE
      ORDNO>(YRX-FLOAT(I-1)*DH)*FSY
      WRITE (6,FOR1) WL,ORDNO,(IMAGE(J),J>I1,I2)
  420 CONTINUE
      IF(KABSC) GO TO 430
      WRITE (6,FOR3) (ABNOS(J),J>1,NVP)
  430 RETURN
C
      ENTRY OMIT(LSW)
      KABSC>MOD(LSW,2).EQ.1
      KORD>MOD(LSW,4).GE.2
      KNOTGL>LSW.GE.4
      RETURN
C
      ENTRY PLTAPE(ITAPE)
C        NOT YET
      RETURN
      END
```

D 44

Option NMP Listing

NMP ..... (Main)

Subroutines

READ

STAT

TTEST

STAND

CORREL

OUT

ARRAY

MINV

GMPRD

GMSUB

TRIANG

FLOW

CLT24

XYSPA

```
C     NMP
C
C     NMP DEVELOPMENT FIXED SEPT. 67
C     INTEGRAL PART OF FRMCA RIVER BASIN SIMULATION MODEL
C     SEE OPERATIONAL HYDROLOGY USING RESIDUALS: BY G.K.YOUNG AND W.C.
C     PISANO FOR THEORETICAL DEVELOPMENT.
C     SEE IBM MAN. 360A-CM-03X  FOR LISTINGS OF MATRIX OPERATIONS.
C     THIS PROGRAM CODED BY W.C.PISANO PHONE NO. 202-962-2904
C
      DIMENSION DATA(25,100,12),XMEAN(25,12,4),XVAR(25,12,4),SITE(18),
     1SKEW(25,12,4),IDIST(3),GRANXM(25,4),GRANSD(25,4),GRANSK(25,4),
     2C(25,25),C1(625),A(25,25),S(625),COTEMI(625),COVSPA(25,25),L(25),
     3M(25),COVVEC(625),B(25,25),A1(625),COVTEM(25,25),RNC(25)
    1 READ(5,10,END=170)SITE
   10 FORMAT(18A4)
      READ(5,20)NYR,NSEAS,NSITE,NSIM,IRPAT
C
C
C
C     SITE--PROJECT TITLE
C     NYR--YEARS OF HISTORICAL RECORD
C     NSEAS--NUMBER OF SEASONS
C     NSITE--NUMBER OF GAGING STATIONS
C     NSIM--YEARS OF OPERATIONAL HYDROLOGY DESIRED
C     IRPAT--RANDOM NUMBER GENERATOR TRIGGER
C     ANY ODD INTERGER (GREATER THAN ZERO)
C
C     IYEAR = YEAR INDEX
C     ISEAS=SEASON INDEX
C     ISITE = SITE INDEX
C
C
   20 FORMAT(10I5)
C
C     SUBROUTINE READ-- FLOWS ARE INPUTED INTO DATA
C
      CALL READ(NYR,NSEAS,NSITE,DATA,SITE)
C
C     SUBROUTINE STAT-- 1. COMPUTES SEASONAL MEANS,STD. DEVN., AND SKEW
C     FOR ALL SITES FOR A  NO TRANSFORM, B LOG10,C  AND SQUARE ROOT.
C     2. COMPUTES GRAND MEAN AND STD. DEVN. FOR ALL SITES FOR TRANSFORMS
C     XMEAN--MEAN   SITE I, SEASON J    TRANSFORM K
C     XVAR-- STD. DEVN.-- SITE I  SEASON J  TRANSFORM K
C     SKEW--SKEW--SITE I SEASON J TRANSFORM K
C     GRANXM--MEAN SITE I ALL SEASONS--TRANSFORM K
C     GRANSD--STD.DEVN.  SITE I ALL SEASONS TRANSFORM K
C
      KEY=0
      N=NYR
   30 IF(KEY)50,50,40
```

NMP 1

```
40    REWIND 4
      DO 45 IYEAR=1,100
      DO 45 ISEAS=1,NSEAS
45    READ(4)(DATA(ISITE,IYEAR,ISEAS),ISITE=1,NSITE)
      REWIND 4
50    CONTINUE
      CALL STAT (N,NSITE,NSEAS,XMEAN,XVAR,SKEW,DATA,GRANXM,GRANSD)
C
C     SUBROUTINE TTEST--COMPUTES T-DIAGNOSTIC  SKEW/S.D. SKEW - FOR EACH
C     TRANSFORM.  STRATEGY---1  COMPUTE STD.ERR. OF SKEWNESS. 2 STANDARD
C     2  STANDARDIZE DATA BY GRAND MEANS AND GRAND STD.DEVN. .
C     3  COMPUTE GRAND SKEWNESS FOR ALL SITES FOR EACH TRANSFORM.
C     4  COMPUTE T FOR EACH SITE--EACH TRANSFORM.
C     5  FIND GRAND T FOR ALL SITES FOR EACH TRANSFORM.  AVERAGE
C
      CALL TTEST (N,NSEAS,NSITE,GRANXM,GRANSD,GRANSK,TDIST,DATA)
C
C
C     FIND MINIMUM T . II IS THE KEY ON TRANSFORM THAT BEST FITS THE
C     NORMALITY REQUIREMENT.
C
      FJ=20.0
      DO 60 I=1,3
      FK=ABS(TDIST(I))
      IF(FK-FJ)70,60,60
70    II=I
      FJ=FK
60    CONTINUE
C
C     SUBROUTINE STAND  STANDARDIZES DATA USING SEASONAL MEANS AND STD.
C     DEVN.  II IS KEY ON TRANSFORM
C     II MUST NOT BE USED AS AN INDEX IN SUBSEQUENT OPERATIONS
C
      CALL STAND(II,NSEAS,N,NSITE,DATA,XMEAN,XVAR)
C
C     SUBROUTINE CORREL--COMPUTES 1  SPACE R--CORRELATION OF SITE I WITH
C     SITE J DURING SAME TIME FRAME--TIME INVARIANT. COVSPA I,J
C     2  SPACE-TIME R-- CORRELATION OF SITE I TIMEFRAME  K  WITH SITE J
C      TIMEFRAME K-1 . SITE I J IS THE LAG CORRELATION FOR SITE ITSELF.
C     COVTEM I,J
C
      CALL CORREL(NSEAS,N,NSITE,DATA,COVSPA,COVTEM)
C
C     SUBROUTINE OUT-- PRINTS STATISTICAL PARAMETERS
C     KEY=0  HISTORICAL STATISTICS
C     KEY   1 GENERATED STATISTICS
C
      IF(KEY)80,80,90
90    N=NSIM
80    CALL OUT (KEY,XMEAN,XVAR,SKEW,TDIST,SITE,GRANXM,GRANSD,GRANSK,
```

NMP 2

```
     1COVSPA,COVTEM,NSITE,N,NSEAS,II)
      IF(KEY)100,100,110
100   CONTINUE
C
C     SUBROUTINE ARRAY--CHANGES MATRICES TO VECTORS AND VICE VERSA.
C
      CALL ARRAY (2,NSITE,NSITE,25,25,COVVEC,COVSPA)
C
C     COVSPA-MATRIX-- COVVEC-- VECTOR
C
      CALL MINV(COVVEC,NSITE,DET,L,M)
C
C     SUBROUTINE MINV--COMPUTES INVERSE--INPUT COVVEC--RETURNS INVERSE
C     INPUT IS DESTROYED.
C
      CALL ARRAY(2,NSITE,NSITE,25,25,COTEM1,COVTEM)
C
C     COTEM1 CONTAINS COVTEM TIME-SPACE COR. MATRIX  IN VECTOR FORM
C
      CALL GMPRD(COTEM1,COVVEC,A1,NSITE,NSITE,NSITE)
C
C     A1 CONTAINS M-1*MO INVERSE  IN VECTOR FORM
C
      CALL ARRAY(1,NSITE,NSITE,25,25,A1,A)
C
C     A          -- VECTOR TO MATRIX
      WRITE(6,120)
120   FORMAT(1H1/1HOBHA MATRIX//)
      DO 130 ISITE=1,NSITE
130   WRITE(6,125)(A(ISITE,JSITE),JSITE=1,NSITE)
C
      CALL GMPRD(A1,COTEM1,ST,NSITE,NSITE,NSITE)
C
C     ST CONTAINS M-1*MO INVERSE *M-1
C
      CALL ARRAY(2,NSITE,NSITE,25,25,COVVEC,COVSPA)
C
C     COVSPA-MATRIX--COVVEC--VECTOR
C
C
C     SUBROUTINE GMSUB X,Y,Z,N,N       X-Y    Z
C
      CALL GMSUB(COVVEC,ST,C1,NSITE,NSITE)
C
C     C1  CONTAINS MO-M-1*MO INVERSE *M-1
C
      CALL ARRAY(1,NSITE,NSITE,25,25,C1,C)
C
C     C  CONTAINS C1 IN MATRIX FORM
C
```

NMP 3

```
C
C     SUBROUTINE TRIANG-- ENTER C MATRIX, SOLVE FOR TRIANGULAR MATRIX B.
C
      CALL TRIANG(B,C,NSITE)
C
      WRITE(6,140)
  125 FORMAT(1H012F10.3)
  140 FORMAT(1H1/1H010X,8HB MATRIX///)
      DO 150 ISITE=1,NSITE
  150 WRITE(6,125)(B(ISITE,JSITE),JSITE=1,ISITE)
C
C     SUBROUTINE FLOW-- FLOW GENERATOR--SEASONAL 1,2,3,4,6,12
C     STANDARDIZED VARIATES ARE GENERATED IN FLOW AND STORED ON TAPE 9
C
      DO 160 ISITE=1,NSITE
  160 RNC(ISITE)=-GRANXM(ISITE,II)/GRANSD(ISITE,II)
      CALL FLOW(NSIM,NSITE,NSEAS,A,B,IRPAT,RNC)
C
C     SUBROUTINE XYSPA--TRANSFORMS GENERATED VARIATES BACK TO XY SPACE.
C     PERFORMS INVERSE TRANSFORM--KEY=II
C     OPERATIONAL FLOWS ARE ON TAPE 4
C     TIME FRAME FOR EACH RECORD BLOCK IS ONE SEASON
C
C
      CALL XYSPA(II,XMEAN,XVAR,DATA,NSITE,NSEAS,NSIM)
C
      KEY=1
      N=100
      GO TO 30
  110 GO TO 1
  170 STOP
C
C     AND THE PROFESSOR(HATJR) ENDS NOT
C     WITH A Q.E.D. BUT WITH AN E.I.E.I.O.
C
      END
      SUBROUTINE READ(NYR,NSEAS,NSITE,DATA,SITE)
       DIMENSION DATA 25,100,12 ,PLACE(18),SITE(18)
      WRITE(6,1)SITE
    1 FORMAT(1H1/1H09HDATA ECHO///1H020X,18A4///1H010X,
     124HGAGING STATION LOCATIONS///)
      DO 2 ISITE=1,NSITE
      READ(5,3)PLACE
    3 FORMAT(18A4)
    2 WRITE(6,4)PLACE
    4 FORMAT(1H 10X,18A4)
      WRITE(6,5)
    5 FORMAT(1H1/1H04HSITE,2X,2HYR//)
      DO 6 ISITE=1,NSITE
      DO 6 IYEAR=1,NYR
```

```
      READ(5,8)(DATA(ISITE,IYEAR,ISEAS),ISEAS=1,NSEAS)
8     FORMAT(12F6.0)
6     CONTINUE
      DO 10 ISITE=1,NSITE
      WRITE(6,7)ISITE
7     FORMAT(1H0/1H0 I3)
      DO 10 IYEAR=1,NYR
10     WRITE(6,9)IYEAR,(DATA(ISITE,IYEAR,ISEAS),ISEAS=1,NSEAS)
9     FORMAT(1H I8,12F10.3)
C
C     ADD 10 UNITS TO EACH FLOW OR QUALITY VALUE
C
      DO 11 ISITE=1,NSITE
      DO 11 IYEAR=1,NYR
      DO 11 ISEAS=1,NSEAS
11    DATA(ISITE,IYEAR,ISEAS)=DATA(ISITE,IYEAR,ISEAS) + 10.0
C
C
      RETURN
      END
      SUBROUTINE STAT(NYR,NSITE,NSEAS,XMEAN,XVAR,SKEW,DATA,GRANXM,GRANSD
     1)
      DIMENSION SKEW(25,12,4),GRANXM(25,4),GRANSD(25,4),XVAR(25,12,4),XM
     1EAN(25,12,4),DATA(25,100,12)
C
C     SEASONAL AND GRAND MOMENTS OF HISTORICAL INPUT
C
      DO 1 ISITE=1,NSITE
      DO 1 KK=1,4
      GRANXM(ISITE,KK)=0.0
      GRANSD(ISITE,KK)=0.0
      DO 1 ISEAS=1,NSEAS
      XMEAN(ISITE,ISEAS,KK)=0.0
      XVAR(ISITE,ISEAS,KK)=0.0
1     SKEW(ISITE,ISEAS,KK)=0.0
      DO 2 KK=1,4
      DO 2 ISITE=1,NSITE
      DO 2 ISEAS=1,NSEAS
      DO 2 IYEAR=1,NYR
      XX=DATA(ISITE,IYEAR,ISEAS)
      GO TO (3,4,5,6),KK
4     XX=ALOG(XX)/2.30259
      GO TO 3
5     XX=SQRT(XX)
      GO TO 3
6     XX=XX-10.0
3     XMEAN(ISITE,ISEAS,KK)=XMEAN(ISITE,ISEAS,KK) + XX
      XVAR(ISITE,ISEAS,KK)=XVAR(ISITE,ISEAS,KK) + XX**2
      GRANXM(ISITE,KK)=GRANXM(ISITE,KK)+XX
      GRANSD(ISITE,KK)=GRANSD(ISITE,KK)+XX**2
```

NMP 5

```
2     SKEW(ISITE,ISEAS,KK)=SKEW(ISITE,ISEAS,KK)+XX**3
      FNYR=NYR
      DO 7 KK=1,4
      DO 7 ISITE=1,NSITE
      DO 7 ISEAS=1,NSEAS
      XMEAN(ISITE,ISEAS,KK)=XMEAN(ISITE,ISEAS,KK)/FNYR
      XV=XVAR(ISITE,ISEAS,KK)
      SS=XVAR(ISITE,ISEAS,KK)-FNYR*XMEAN(ISITE,ISEAS,KK)**2
      XVAR(ISITE,ISEAS,KK)=SQRT(ABS(SS/FNYR))
7     SKEW(ISITE,ISEAS,KK)=(SKEW(ISITE,ISEAS,KK)-3.0*XMEAN(ISITE,ISEAS,K
     1K)*XV+2.0*FNYR*XMEAN(ISITE,ISEAS,KK)**3)/(FNYR*XVAR(ISITE,ISEAS,KK
     1)**3)
      FN=NSEAS*NYR
      DO 8 KK=1,4
      DO 8 ISITE=1,NSITE
      GRANXM(ISITE,KK)=GRANXM(ISITE,KK)/FN
      SS=GRANSD(ISITE,KK)-FN*GRANXM(ISITE,KK)**2
8     GRANSD(ISITE,KK)=SQRT(ABS(SS/FN))
      RETURN
      END
      SUBROUTINE TTEST(NYR,NSEAS,NSITE,GRANXM,GRANSD,GRANSK,TDIST,DATA)
      DIMENSION GRANXM(25,4),GRANSD(25,4),GRANSK(25,4),TDIST(3),DATA(25,
     1100,12),ISITE(25,3)
      FNYR=NYR
      SESK=SQRT((6.0*(FNYR-2.0))/((FNYR+1.0)*(FNYR+3.0)))
C
C     STD. DEVN. OF SKEWNESS
C
      DO 1 K=1,3
1     TDIST(K)=0.0
C
C     STANDARDIZING USING GRAND STATISTICS
C
      DO 3 KK=1,4
      DO 3 ISITE=1,NSITE
      GRANSK(ISITE,KK)=0.0
      DO 3 IYEAR=1,NYR
      DO 3 ISEAS=1,NSEAS
      XX=DATA(ISITE,IYEAR,ISEAS)
      GO TO (4,5,6,7),KK
5     XX=ALOG(XX)/2.3059
      GO TO 4
6     XX=SQRT(XX)
      GO TO 4
7     XX=XX-10.0
4     XX=(XX-GRANXM(ISITE,KK))/GRANSD(ISITE,KK)
      GRANSK(ISITE,KK)=GRANSK(ISITE,KK)+XX**3
3     CONTINUE
      FF=NYR*NSEAS
      DO 8 KK=1,4
```

NMP 6

```
      DO 8 ISITE 1,NSITE
8     GRANSK(ISITE,KK)=GRANSK(ISITE,KK)/FF
      DO 9 KK=1,3
      DO 9 ISITE=1,NSITE
C
C     T FOR EACH SITE
C
      TSITE(ISITE,KK)=GRANSK(ISITE,KK)/SESK
9     TDIST(KK)=TDIST(KK)+TSITE(ISITE,KK)
      FS=NSITE
C
C     GRAND T FOR EACH DISTRIBUTION
C
      DO 10 KK=1,3
10    TDIST(KK)=TDIST(KK)/FS
      RETURN
      END
      SUBROUTINE STAND(II,NSEAS,NYR,NSITE,DATA,XMEAN,XVAR)
       DIMENSION DATA 25,100,12 ,XMEAN(25,12,4),XVAR(25,12,4)
C
C     STANDARDIZING BY SEASONS
C
      DO 1 ISITE=1,NSITE
      DO 1 IYEAR=1,NYR
      DO 1 ISEAS=1,NSEAS
      IF(II-2)1,2,3
2     DATA(ISITE,IYEAR,ISEAS)=ALOG(DATA(ISITE,IYEAR,ISEAS))/2.30259
      GO TO 1
3     DATA(ISITE,IYEAR,ISEAS)=SQRT(DATA(ISITE,IYEAR,ISEAS))
1     DATA(ISITE,IYEAR,ISEAS)=(DATA(ISITE,IYEAR,ISEAS)-XMEAN(ISITE,ISEAS
     1,II))/XVAR(ISITE,ISEAS,II)
C
C     DATA NOW CONTAINS STANDARDIZED VAR
C
      RETURN
      END
      SUBROUTINE CORREL (NSEAS,N,NSITE,DATA,COVSPA,COVTEM)
      DIMENSION DATA(25,100,12),COVSPA(25,25),COVTEM(25,25),DSS(25)
      FN = N*NSEAS
      DO 1 ISITE=1,NSITE
      DO 1 JSITE=1,NSITE
      COVSPA(ISITE,JSITE)=0.0
1     COVTEM(ISITE,JSITE)=0.0
C
C     SPATIAL CORRELATION ANALYSIS
C
      DO 2 ISITE=1,NSITE
      DO 2 IYEAR=1,N
      DO 2 ISEAS=1,NSEAS
C
```

NMP 8

```
C     CENTERED SUM OF CROSS PRODUCTS
C
      DO 3 JSITE=1,ISITE
3     COVSPA(ISITE,JSITE)=COVSPA(ISITE,JSITE)+DATA(ISITE,IYEAR,ISEAS)*
     1DATA(JSITE,IYEAR,ISEAS)
2     CONTINUE
C
C     SPACE-TIME CORRELATION
C
      DO 4 ISITE=1,NSITE
      DO 4 IYEAR=1,N
      DO 4 ISEAS=1,NSEAS
      JYEAR=IYEAR
      KSEAS=ISEAS+1
      IF(ISEAS-NSEAS)5,6,6
6     IF(JYEAR-N)7,8,8
7     JYEAR=JYEAR+1
      KSEAS=1
5     CONTINUE
C
C     CENTERED SUM OF CROSS PRODUCTS ONE TIME FRAME APART.
C
      DO 9 JSITE=1,NSITE
9     COVTEM(ISITE,JSITE)=COVTEM(ISITE,JSITE)+DATA(ISITE,IYEAR,ISEAS)*
     1DATA(JSITE,JYEAR,KSEAS)
      GO TO 4
8     DO 10 JSITE=1,NSITE
10    COVTEM(ISITE,JSITE)=COVTEM(ISITE,JSITE)+DATA(ISITE,1,1)*DATA(JSITE
     1,N,NSEAS)
4     CONTINUE
      DO 11 ISITE=1,NSITE
11    DSS(ISITE)=SQRT(COVSPA(ISITE,ISITE))
      DO 12 ISITE=1,NSITE
      DO 12 JSITE=1,ISITE
12    COVSPA(JSITE,ISITE)=COVSPA(ISITE,JSITE)
      DO 13 ISITE=1,NSITE
      DO 13 JSITE=1,NSITE
      COVTEM(ISITE,JSITE)=COVTEM(ISITE,JSITE)/FM
13    COVSPA(ISITE,JSITE)=COVSPA(ISITE,JSITE)/(DSS(ISITE)*DSS(JSITE))
      RETURN
      END
      SUBROUTINE TRIANG(B,C,N)
      DIMENSION B(25,25),C(25,25)
C
C     CALLS DIAG TO COMPUTE DIAGONAL ELEMENTS.
C     CALL OFFDIAG TO COMPUTE OFF DIAGONAL ELEMENTS.
C
      DO 1 I=1,N
      DO 1 J=1,I
      C(I,J)=(C(I,J)+C(J,I))*0.5
```

```
1     C(J,I)=C(I,J)
      WRITE(6,10)
10    FORMAT(1H1/1H010X,12H    C MATRIX///)
      DO 15  I=1,N
15    WRITE(6,20)(C(I,J),J=1,N)
20    FORMAT(1H0 12F10.3)
      DO 2 I=1,N
      L=I
      LL=L
      DO 3 K=LL,N
      IF(K.EQ.L) GO TO 4
      CALL OFFDIG(K,L,C,B,N)
      GO TO 3
4     CALL DIAG(K,C,B,N)
3     CONTINUE
2     CONTINUE
      RETURN
      END
      SUBROUTINE DIAG(M,C,B,N)
      DIMENSION B(25,25),C(25,25)
      IF(M.EQ.1) GO TO 1
      A=0.0
      KK=M-1
      DO 2 IM=1,KK
2     A=A+ B(M,IM)**2
      B(M,M)=C(M,M)-A
      IF(B(M,M))3,3,4
3     B(M,M)=0.0
      GO TO 5
4     B(M,M)= SQRT(B(M,M))
      GO TO 5
1     B(M,M)=SQRT(C(M,M))
5     CONTINUE
      RETURN
      END
      SUBROUTINE OFFDIG(K,L,C,B,N)
      DIMENSION B(25,25),C(25,25)
      IF(L.EQ.1)GO TO 1
      A=0.0
      MM=L-1
      DO 2 IM=1,MM
2     A=A+B(K,IM)*B(L,IM)
      B(K,L)=C(L,K)-A
      IF(B(L,L))3,3,4
3     B(K,L)=0.0
      GO TO 5
4     CONTINUE
      B(K,L)=B(K,L)/B(L,L)
      GO TO 5
1     B(K,L)=C(L,K)/B(L,L)
```

```
    5   CONTINUE
        RETURN
        END
        SUBROUTINE CLT24(IX,X)
        DIMENSION R(24)
C
C       RANDOM NUMBER GENERATOR
C
C
C       N.B.--
C       THIS ROUTINE IS ONLY GOOD FOR IBM 360/65
C       FOR OTHER MACHINES A MODIFIED RANDOM NUMBER SUBROUTINE MUST BE COD
C
        DO 1 I=1,24
        IY=IX*65539
        IF(IY)2,3,3
    2   IY=IY+2147483647+1
    3   YFL=IY
        IX=IY
    1   R(I)=YFL*.4656613E-9
        SUM=0.0
        DO 4 I=1,24
    4   SUM=SUM+R(I)
        X=(SUM/1.41421)-8.48526
        RETURN
        END
        SUBROUTINE FLOW(NSIM,NSITE,NSEAS,A,B,IRPAT,RNC)
        DIMENSION OPREV(25),OCUR(25),RANNUM(25),A(25,25),B(25,25),RNC(25)
        DIMENSION OSTOR(25,12)
C
C       INITIALIZE OI-1
C
        DO 1 ISITE=1,NSITE
    1   OPREV(ISITE)=0.0
C
C       NUMBER OF PERIODS TO BE GENERATED
C
        MSIM=NSIM*NSEAS
        REWIND 9
        DO 2 JFRAM=1,MSIM
        DO 3 ISITE=1,NSITE
        CALL CLT24(IRPAT,XXX)
    3   RANNUM(ISITE)=XXX
C
C       OI   A*OI-1   B*E
C
        DO 4 ISITE=1,NSITE
        OCUR(ISITE)=0.0
        DO 5 JSITE=1,NSITE
    5   OCUR(ISITE)=A(ISITE,JSITE)*OPREV(JSITE)+OCUR(ISITE)
```

NMP 10

```
      OSTOC=0.0
      DO 6  IK=1,ISITE
    6 OSTOC=OSTOC+B(ISITE,IK)*RANNUM(IK)
    4 OCUR(ISITE)=UCUR(ISITE)+OSTOC
      DO 7 ISITE=1,NSITE
      IF(OCUR(ISITE).LT.RNC(ISITE))OCUR(ISITE)=RNC(ISITE)
    7 CONTINUE
      DO 8 ISITE=1,NSITE
    8 OPREV(ISITE)=OCUR(ISITE)
      KSEAS=1
      DO 9 ISITE=1,NSITE
    9 OSTOR(ISITE,KSEAS)=OCUR(ISITE)
C
C     NOTE--
C     THE FOLLOWING WRITE STATEMENT DICTATES THE ARRANGEMENT OF THE
C     OPERATIONAL DATA ON THE (SYNTHETIC) FLOW TAPE
      WRITE(9)(OSTOR(ISITE,KSEAS),ISITE=1,NSITE)
C
    2 CONTINUE
      REWIND 9
      RETURN
      END
      SUBROUTINE XYSPA(II,XMEAN,XVAR,DATA,NSITE,NSEAS,NSIM)
      DIMENSION XMEAN(25,12,4),XVAR(25,12,4),DATA(25,100,12),Q(25,12)
      REWIND 9
      REWIND 4
C
C     INVERSE TRANSFORMATION--KEY ON TRANSFORM IS II
C
      DO 2 IYEAR=1,NSIM
      DO 20 ISEAS=1,NSEAS
   20 READ(9)(Q(ISITE,ISEAS),ISITE=1,NSITE)
      DO 3 ISITE=1,NSITE
      DO 3 ISEAS=1,NSEAS
      Q(ISITE,ISEAS)=XMEAN(ISITE,ISEAS,II)+Q(ISITE,ISEAS)*XVAR(ISITE,
     1ISEAS,II)
      Q(ISITE,ISEAS)=AMAX1(Q(ISITE,ISEAS),.1)
      IF(II-2)6,4,5
    4 AM=Q(ISITE,ISEAS)
      Q(ISITE,ISEAS)=10.0**AM
      GO TO 6
    5 Q(ISITE,ISEAS)=Q(ISITE,ISEAS)**2
    6 Q(ISITE,ISEAS)=Q(ISITE,ISEAS)-10.0
      Q(ISITE,ISEAS)=AMAX1(Q(ISITE,ISEAS),0.1)
    3 CONTINUE
      DO 30 ISEAS=1,NSEAS
   30 WRITE(4)(Q(ISITE,ISEAS),ISITE=1,NSITE)
    2 CONTINUE
      REWIND 4
C
```

```
C     OPERATIONAL HYDROLOGY IS NOW STORED ON TAPE 4
C
      RETURN
      END
      SUBROUTINE OUT(KEY,XMEAN,XVAR,SKEW,TOIST,SITE,GRANXM,GRANSD,GRANSK
     1,COVSPA,COVTEM,NSITE,NYR,NSEAS,II)
      DIMENSION XMEAN(25,12,4),XVAR(25,12,4),SKEW(25,12,4),TOIST(3),SITE
     1(18),GRANXM(25,4),GRANSD(25,4),GRANSK(25,4),COVTEM(25,25),COVSPA(2
     25,25)
      REAL NOMON(3)
      DATA NOMON/: NO:,: LOG:,:SQRT:/
C
C     PRINTING SUBROUTINE
C
      WRITE(6,1) SITE,NSITE,NYR,NSEAS
    1 FORMAT(1H1/1H050X,7HPROJECT/10X,18A4//20X,I10,2X,15HGAGING STATION
     1S//20X,I10,2X,15HYEARS OF RECORD/20X,I10,2X,7HSEASONS//)
      K=4
      IF(KEY)2,2,3
    2 WRITE(6,4)
    4 FORMAT(1H1/1H020X,26HHISTORICAL RECORD ANALYSIS//)
      GO TO 6
    3 WRITE(6,5)
      K=1
    5 FORMAT(1H1/1H020X,25HGENERATED RECORD ANALYSIS//
     11H050HFIRST 100 YEARS OF GENERATED TRACE USED IN ANALYSIS//)
    6 DO 7 ISEAS=1,NSEAS
      DO 7 ISEAS=1,NSEAS
      WRITE(6,8)
    8 FORMAT(1H1//1H06HSEASON//)
      IF(KEY)9,9,10
    9 WRITE(6,11)
   11 FORMAT(1H010X,10HHISTORICAL/)
      GO TO 12
   10 WRITE(6,13)
   13 FORMAT(1H010X,9HSIMULATED//)
   12 WRITE (6,14)
   14 FORMAT(1H06X,4HSITE,12X,4HMEAN,12X,4HS.D.,12X,4HSKEW,12X4HC.V.//)
      WRITE(6,15)ISEAS
   15 FORMAT(1H0I3//)
      DO 16 ISITE=1,NSITE
      CV=XVAR(ISITE,ISEAS,K)/XMEAN(ISITE,ISEAS,K)
   16 WRITE(6,17)ISITE,XMEAN(ISITE,ISEAS,K),XVAR(ISITE,ISEAS,K),SKEW(
     1ISITE,ISEAS,K),CV
    7 CONTINUE
   17 FORMAT(6X,I4,4E16.4)
      WRITE(6,18)
   18 FORMAT(1H1/1H016HGRAND STATISTICS//)
      IF(KEY)19,19,20
   19 WRITE(6,11)
```

NMP 12

```
      GO TO 21
 20   WRITE(6,13)
 21   WRITE(6,14)
      DO 22 ISITE=1,NSITE
      CV=GRANSD(ISITE,K)/GRANKM(ISITE,K)
 22   WRITE(6,17)ISITE,GRANKM(ISITE,K),GRANSD(ISITE,K),GRANSK(ISITE,K),
     1CV
      IF(KEY)23,23,24
 23   WRITE(6,25)
 25   FORMAT(1H1/1H0/22HSCALED SKEWNESS VALUES)
      RETURN
      WRITE(6,26)GN
 26   FORMAT(1H0/1H0/6HTHESE NUMBERS ARE THE AVERAGE SKEWNESS DIVIDED BY
     1 THE STANDARD ERROR OF THE SKEWNESS FOR,I5,2X,12HOBSERVATIONS)
      WRITE(6,27)(DIST(ITRANS),ITRANS=1,3)
 27   FORMAT(1H0/1H0,10X,12HNO TRANSFORM,10X,6HLOG 10,
     110X,11HSQUARE ROOT/10X F12.3,10X,F6.3,10XF11.3)
      WRITE(6,28)DOMAIN(I)
 28   FORMAT(1H0/1H0,10X,:MINIMUM SKEWNESS OCCURS WHEN :,A4,: TRANSFORM
     1 IS USED TO TRANSFORM THE MATRIX OF RESIDUALS:)
 24   CONTINUE
      WRITE(6,29)
 29   FORMAT(1H1/1H0 59HSPATIAL CORRELATION MATRIX, CROSS CORRELATION BE
     1TWEEN SITES//)
      IF(KEY)30,30,31
 30   WRITE(6,11)
      GO TO 34
 31   WRITE(6,13)
 34   DO 32 ISITE=1,NSITE
 32   WRITE(6,33)ISITE,(COVSPA(ISITE,JSITE),JSITE=1,NSITE)
 33   FORMAT(1H0I4,(10F12.3))
      WRITE(6,35)
 35   FORMAT(1H1:LAG ONE CORRELATION MATRIX.:/1H :DIAGONAL ELEMENTS ARE
     1LAG COR. OF EACH SITE .:/1H :OFF DIAGONAL ELEMENTS ARE LAG COR. OF
     2 SITE I WITH SITE J.://)
      DO 36 ISITE=1,NSITE
 36   WRITE(6,33)ISITE,(COVTEM(ISITE,JSITE),JSITE=1,NSITE)
      RETURN
      END
      SUBROUTINE MINV(A,N,D,L,M)
C     TO INVERT A MATRICS
      DIMENSION A(1),L(1),M(1)
      D=1.0
      NK=-N
      DO 80 K=1,N
      NK=NK+N
      L(K)=K
      M(K)=K
      KK=NK+K
      BIGA=A(KK)
```

NMP 13

```
      DO 20 J=K,N
      IZ=N*(J-1)
      DO 20 I=K,N
      IJ=IZ+I
   10 IF(ABS(BIGA)-ABS(A(IJ))) 15,20,20
   15 BIGA=A(IJ)
      L(K)=I
      M(K)=J
   20 CONTINUE
      J=L(K)
      IF(J-K) 35,35,25
   25 KI=K-N
      DO 30 I=1,N
      KI=KI+N
      HOLD=-A(KI)
      JI=KI-K+J
      A(KI)=A(JI)
   30 A(JI)=HOLD
   35 I=M(K)
      IF(I-K) 45,45,38
   38 JP=N*(I-1)
      DO 40 J=1,N
      JK=NK+J
      JI=JP+J
      HOLD=-A(JK)
      A(JK)=A(JI)
   40 A(JI)=HOLD
   45 IF(BIGA) 48,46,48
   46 D=0.0
      RETURN
   48 DO 55 I=1,N
      IF(I-K) 50,55,50
   50 IK=NK+I
      A(IK)=A(IK)/(-BIGA)
   55 CONTINUE
      DO 65 I=1,N
      IK=NK+I
      IJ=I-N
      DO 65 J=1,N
      IJ=IJ+N
      IF(I-K) 60,65,60
   60 IF(J-K) 62,65,62
   62 KJ=IJ-I+K
      A(IJ)=A(IK)*A(KJ)+A(IJ)
   65 CONTINUE
      KJ=K-N
      DO 75 J=1,N
      KJ=KJ+N
      IF(J-K) 70,75,70
   70 A(KJ)=A(KJ)/BIGA
```

NMP 14

```
 75   CONTINUE
      D=D*BIGA
      A(KK)=1.0/BIGA
 80   CONTINUE
      K=N
100   K=(K-1)
      IF(K) 150,150,105
105   I=L(K)
      IF(I-K) 120,120,108
108   JQ=N*(K-1)
      JR=N*(I-1)
      DO 110 J=1,N
      JK=JQ+J
      HOLD=A(JK)
      JI=JR+J
      A(JK)=-A(JI)
110   A(JI)=HOLD
120   J=M(K)
      IF(J-K) 100,100,125
125   KI=K-N
      DO 130 I=1,N
      KI=KI+N
      HOLD=A(KI)
      JI=KI-K+J
      A(KI)=-A(JI)
130   A(JI)=HOLD
      GO TO 100
150   RETURN
      END
      SUBROUTINE GMPRD(A,B,R,N,M,L)
      DIMENSION A(1),B(1),R(1)
      IR=0
      IK=-M
      DO 10 K=1,L
      IK=IK+M
      DO 10 J=1,N
      IR=IR+1
      JI=J-N
      IB=IK
      R(IR)=0
      DO 10 I=1,M
      JI=JI+N
      IB=IB+1
 10   R(IR)=R(IR)+A(JI)*B(IB)
      RETURN
      END
      SUBROUTINE GMSUB(A,B,R,N,M)
      DIMENSION A(1),B(1),R(1)
      NM=N*M
      DO 10 I=1,NM
```

```
   10 S(I)=A(I)-B(I)
      RETURN
      END
      SUBROUTINE ARRAY (MODE,I,J,N,M,S,D)
      DIMENSION S(1),D(1)
      NI=N-I
      IF(MODE-1) 100,100,120
  100 IJ=I*J+1
      NM=N*J+1
      DO 110 K=1,J
      NM=NM-NI
      DO 110 L=1,I
      IJ=IJ-1
      NM=NM-1
  110 D(NM)=S(IJ)
      GO TO 140
  120 IJ=0
      NM=0
      DO 130 K=1,J
      DO 125 L=1,I
      IJ=IJ+1
      NM=NM+1
  125 S(IJ)=D(NM)
  130 NM=NM+NI
  140 RETURN
      END
/*
```

OPTION B LISTING

MAIN

EXECUTIVE

Overlay 1 Routines

CHAIN5 ..... (Main)

Subroutines

TITLE	DATIN1	DATIN2
DATIN3	DATFEW	SET
SET1	ECHO1	ECHO2
ECHO3	UNREGG	CLT24
SALT	STORER	FRAMUP
EXTPNT	WASTE	DAMSET
EVAP	DAMGO	FJUNC
TESDIR	TESTP	TESCHK
ROUTE	SEARCH	RESTOR
TAPOT1	WRITOT	TAPOT2

Overlay 2 Routines

CHAIN6 ..... (Main)

Overlay 3 Routines

CHAIN 7 ..... (Main)

```
C
C     EXECUTIVE ROUTINE
C
98    READ(5,100)INVES
100   FORMAT(I1)
99    GO TO (1,2,3,4,5,6,7),INVES
C
C     CALLS TO INVES = 1,2,3,4 ARE DUMMY AT THIS TIME.
C
1     GO TO 10
2     GO TO 10
3     GO TO 10
4     GO TO 10
C
C     ROUTING LINK
C
5     CALL CHAIN5(INVES)
      IF(INVES-5)99,98,99
C
C     OUTPUT LINK 1
C
6     CALL CHAIN6(INVES)
      GO TO 99
C
C     OUTPUT LINK 2
C
7     CALL CHAIN7(INVES)
      GO TO 98
10    STOP
      END
      SUBROUTINE CHAIN5(INVES)
C     MAIN
      DIMENSION PLACE(18),NTYPE(50),NEXT(50),KGAGE(50),FACTOR(50),CR(50)
     1,JUNC(10),QOLD(50),Q(50),RN(150),JUNK(50),CAP(15),DEAD(15),S(15),
     2DEFTMP(15,12),DEF (15,12),DEFH(15,12),ITRAN(15),TRA DIR(15,12),
     3ITYPIP(15),FLOMIN(10),FLCMIN(10,5),AVHO(10,1,12),SDHO(10,1,12),
     4AVCUMC(10,5,12),SDCUMC(10,5,12),NSERVE(25),KSERVE(25,10),AVNEED(25
     5,12),SDNEED(25,12),CRIT(25,5,12),ITPFLD(25),FLOW(50),IDAMEV(15),
     6EVPXM(3,12),EVPSD(3,12),IRFEV(15),FACEVP(15),ACOEVP(15),XCOEVP(15)
     7,DAMSS(15,5),MOHCON(50),TEM R(12),EMIL(50),CONSTV(50),EXPV(50),
     8OXYMAS(50),OXYDAM(15),RIGCO(5,50),ACONT(5,50),SFSALT(5,50),
     9TESALT(5,50),WA(18,5),          AMBENT(50,5),QULMAX(25,5)
      DIMENSION QULMIN(25,5),NDEFY(25,12),NDX3(25,6),NDX(25,6,12),
     1DEFFCM(25,6,12),QOX(50,12),LODAM(15),LOJUNK(25),DAMCON(50,5),
     2MONIT(12),YRSUM(25),FLOWIR(50),REQU(50),INDAM(50),FLOQUL(50,5),
     3ISUP(15),NNREG(50),FRANK(5,50),QQ(50),DEFMAX(25),IWATER(25),
     4MFILL(15),MDRY(15),QOTSAV(50),AMSAVE(50,5),STSAVE(15),NDRY2(15),
     5QQLD2(50),DAMSAV(50,5),AMBEN2(50,5),NDEFY2(25,12),NDX2(25,6,12),
     6NDX4(25,6),MON(20),ISALMP(50),DAMMAX(15,5),DAMMIN(15,5),DEFY(25,6)
     7,MFILL2(15),DEFX(25),YRMAX(25),YRCUM(25)
```

```
C
C     ************************************************************
C     MODEL BASIN- W.C.PISANO DIV. OF TECHNICAL CONTROL- F.W.P.C.A.
C     INTEGRAL  PART OF FWPCA RIVER BASIN SIMULATION PROGRAM
C     ************************************************************
C
C     BASIC CONTROL AND GEOMETRY CARDS.
C     THIS INPUT WILL REMAIN UNCHANGED FOR ALL RUNS
C
      REWIND 2
      REWIND 3
      REWIND 10
C
C     RIVER BASIN TITLE
      READ(5,10)PLACE
C
10    FORMAT(18A4)
C
C     NPOINT-NUMBER OF POINTS  WHICH DEFINE SYSTEM.
C
C     NSTART-COORD. AT WHICH ROUTING WILL START IN EACH TIME FRAME.
C
C     NSEAS-- NUMBER OF SEASONS PER YEAR (1,2,3,4,6,12)
C
C     NGAGES-NUMBER OF FLOW AND WATER QUALITY MONITORING GAGES WHICH
C     WILL BE USED IN THE ROUTING TO DEFINE AMBIENT STREAM FLOW AND
C     QUALITY.
C
C     NRUNS-NUMBER OF PLANS TO BE INVESTIGATED.
C
      READ (5,20 )NPOINT,NSTART,NSEAS,NGAGES,NRUNS
C
C     NTYPE-NUMERIC DESCRIPTION OF EACH COORD-(1-TEST, 2-WASTE, 3-DAM,
C     4-CONFLUENCE, 5-END)
C
      READ (5,20 )(NTYPE(I),I=1,NPOINT)
C
C     NEXT-IMMEDIATE DOWNSTREAM COORD. OF EACH COORD. PROCEEDING IN
C     CONSECUTIVE NUMERIC ORDER.
C
      READ (5,20 )(NEXT(I),I=1,NPOINT)
C
C     KGAGE-MAP RELATING EACH COORD. TO THE FLOW GAGING STATION WHICH,
C     WHEN SCALED BY THE CORRESPONDING ELEMENT IN FACTOR, WILL DEFINE
C     THE HYDROLOGIC INFLOW INTO THAT COORD.
C
      READ (5,20 )(KGAGE(I),I=1,NPOINT)
C
C     FACTOR- TIME-INVARIANT FACTOR SCALING THE FLOW AT GAGING STATIONS
C     TO FLOWS AT COORD.
```

```
C
      READ (5,25 )(FACTOR(I),I=1,NPOINT)
20    FORMAT(10I5)
25    FORMAT(5F10.0)
      WRITE(2)NRUNS
      NEND=0
      NDAMS=0
      NTESTS=0
      NWASTE=0
      NJUNC=0
C
C     CR-MODIFIED GILCHRIST ROUTING COEFF.WHICH IS USED TO ROUTE FLOWS .
C
      DO 30 I=1,NPOINT
      CR(I)=1.0
C
C     THIS MAKES THE ASSUMPTION OF INSTANTANEOUS FLOW OVER THE BASIC
C     TIME BASE-- PROGRAM IS STILL ADAPTED FOR ROUTING BY THE MODIFIED
C     GILCHRIST ROUTING TECHNIQUE.
C
      NT=NTYPE(I)
      GO TO (40,50,60,70,80),NT
C
C     NTESTS- NUMBER OF TEST POINTS
C
40    NTESTS=NTESTS+1
      GO TO 30
C
C     NWASTE- NUMBER OF WASTE INPUT SITES
C
50    NWASTE=NWASTE+1
      GO TO 30
C
C     NDAMS  NUMBER OF EITHER EXISITING OR PROPOSED DAM SITES.
C
60    NDAMS=NDAMS+1
      GO TO 30
C
C     NJUNC- NUMBER OF CONFLUENCE POINTS
C     ALL CONFLUENCE POINTS WILL BE BY DEFINITION TEST POINTS
C
70    NJUNC=NJUNC+1
      GO TO 30
C
C     NEND- END POINT- TERMINUS OF SYSTEM
C
80    NEND=NEND+1
30    CONTINUE
C
C
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```
      NSER=NTESTS+NJUNC
C
C     DIMENSIONALITY CHECK
C
      IF(NEND-1)90,100,90
90    WRITE(6,110)NEND
      CALL EXIT
110   FORMAT (1H1I5,2X,11HEND POINTS.)
100   NRUNS=MAX0(1,NRUNS)
      IF(NDARS-15)115,115,120
120   WRITE(6,125)NDARS
125   FORMAT (1H116HARRAY TOO LARGE,I10)
      CALL EXIT
115   IF(NWASTE-10)130,130,135
135   NDARS=NWASTE
      GO TO 120
130   IF(NJUNC-10)140,140,145
145   NDARS=NJUNC
      GO TO 120
140   IF(NJUNC)150,150,155
C
C     JUNC-COORD. OF EXTREME POINT ON TRIB. TO WHICH THE ROUTING WILL
C     PROCEED WHEN A JUNCTION POINT IS ENCOUNTERED.
C     NOTA BENE--  ANY ENTRY IN JUNC MUST NOT APPEAR IN NEXT.
C
155   READ(5,20)(JUNC(I),I=1,NJUNC)
C
C     END OF BASIC CONTROL AND GEOMETRY CARDS
C
C     ****************************************************************
C     ****************************************************************
C
C     IRUN- RUN INDEX
C
150   IRUN=1
C
C     THE PROGRAM ITERATES AT THIS POINT TO INVESTIGATE NRUNS.
C
180   IF(IRUN-NRUNS)160,160,170
160   READ(5,190)NYRS,NWVBLS,NTAPE,NSKIP,NFEW,ND,ITRDIV,IPIPE,IRPAT,IOPT
     1,ISALT,IFLOD,IEVAP
C
C     NYRS- NUMBER OF YEARS OF ROUTING
C
C     NWVBLS- NUMBER OF WASTE POLLUTANTS.  WASTE SITES MAY BE USED
C     WITHOUT SPECIFYING WASTE POLLUTANTS.
C     1. CONSERVATIVE - NO BACKGROUND (NATURAL) CONCENTRATIONS.
C     EX. INDUSTRIAL WASTES. CHROMATES.
C     2. CONSERVATIVE - BACKGROUND CONCENTRATIONS CONSIDERED.
C     EX. T.D.S., CL, SO4.
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C     DEGRADABLE-BACKGROUND CONCENTRATION CONSIDERED.
C     EX. BOD.
C     GENERALLY NOT RECCOMENDED. WATER QUALITY STD. OR TARGET MUST BE IN
C     SAME UNITS AND TIME AND SPACE DISCRETIZATION IS USUALLY VERY LARGE
C     OR TOO COARSE FOR ADEQUATE REPRESENTATION .
C
C     NTAPE- LOGICAL TAPE NUMBER OF THE TAPE WHICH CONTAINS EITHER
C     HISTORICAL FLOWS AT GAGING STATIONS OR PREVIOUSLY PREPARED
C     OPERATIONAL (SYNTHETIC) TRACES.
C
C     NSKIP- YEAR ON THE FLOW TAPE RECKONED FROM THE START AT WHICH
C     ROUTING WILL BEGIN. N.B.- THE TAPE WILL BE POSITIONED AT THE
C     BEGINNING AT THE TERMINUS OF EACH PLAN (IRUN)
C
C     NFEW- OPTION KEY THAT ALLOWS REPLACEMENT OF A FEW DESIGN PARAMETER
C     AT THE ONSET OF THE SECOND AND SUBSEQUENT RUNS. N.B.-  THE DATA RE
C     TO FOR THE FIRST RUN IS STORED IN MEMORY. THIS OPTION NEED NOT BE
C     EXERCISED, IMPLYING THAT FOR THE SECOND AND SUBSEQUENT RUNS ALL
C     DESIGN DATA CAN BE COMPLETELY REPLACED.
      CONTINUE
C
C     ND-IF SCALING VECTOR-FACTOR-IS TO TRANSLATE FLOWS FROM GAGES TO
C     SITES WHERE THE FLOW INTO THE ITH SITE IS THE TOTAL FLOW INTO THAT
C     SITE, THEN ND=1.  IF THE MAPPING IS INTENDED TO SPECIFY FLOWS AS
C     UNREGULATED FLOWS, THAT IS, THE FLOW BETWEEN SITES, THEN ND=0.
C     SEE SUBROUTINE UNREGG.
C
C     ITRDIV- KEY- IF EXPLICIT DIVERSIONS ARE TO BE MADE FROM ANY DAM
C     TO A  TEST POINT THAT MAY OR MAY NOT BE CONNECTED HYDRAULICALLY ,
C     THEN ITRDIV=1. EXPLICIT MEANS THAT THE DIVERSION IS MADE REGARDLES
C     OF THE SYSTEM STATE OF THE RECEIVING POINT.
C     IF A DAM IS TO MAKE DIVERSION RELEASES AND THEN OPERATE BY SOME
C     RULES, THEN THE PRIORITY IS SET FOR THE FORMER.
C     NOTE - SEASONAL QUANTITIES OF DIVERSION WATERS ARE EXPECTED
C     BY THE PROGRAM FOR EACH DAM SITE.
C
C     IPIPE- THE SAME AS ITRDIV EXCEPT THAT THE DIVERSIONS ARE MADE
C     AFTER THE STATE OF THE RECEIVING TEST POINT HAS BEEN INTERROGATED.
C     A WATER QUALITY TARGET OR A FLOW REQUIREMENT CAN BE SATISFIED BY
C     THIS OPTION. NOTE- THE TARGET VALUES ARE READ IN AS TEST POINT
C     DATA AND NOT AS DAM DATA.
      CONTINUE
C     THESE RELEASES ARE COMPUTED AFTER THE DAMS DELIVER  THE TRANSBASIN
C     DIVERSIONS(ITRDIV) AND AFTER THE RESERVOIRS MAKE RELEASES IN
C     ACCORDANCE WITH THEIR INPUT RULE CURVES( SEE DEFTMP,DEFC,DEFB).
C
C     IRRAT- RANDOM NUMBER TRIGGER ( ANY ODD INTEGER  GREATER THAN ZERO)
C
C     IOPT- AFTER THE RESERVOIRS HAVE MADE TRANSBASIN DIVERSIONS, DRAFTE
C     IN ACCORDANCE TO SPECIFIED RULES, AND MADE CONDITIONAL DIVERSIONS
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C     FOR EITHER WATER QUALITY OR FLOW TARGETS, THEY THEN CAN BE
C     SEARCHED TO PROVIDE AUGMENTATIONS FOR DOWNSTREAM WATER QUALITY OR
C     FLOW NEEDS.  SPECIFICATION OF RESERVOIRS FOR THIS FUNCTION IS
C     ACCOMPLISHED BY INPUT (NSERVE,KSERVE).  IF MORE THAN ONE RESERVOIR
C     IS SPECIFIED TO MAKE RELEASES FOR A DOWNSTREAM TEST POINT, THEN
C     SEVERAL OPTIONS ARE AVAILABLE TO CALCULATE THESE RELEASES.
C     OPT=1--     DEMAND IS TO BE SPLIT EVENLY BY ALL THE DAMS SPECIFIED.
C     OPT=2--     DEMAND IS APPORTIONED BY THE AVAILABLE STORAGE IN THE
C     SPECIFIED RESERVOIRS
C     OPT=3-- THE DEMAND IS SATISFIED BY SEQUENTENTIALLY DEPLETING THE
C     SERIES OF SPECIFIED RESERVOIRS. THE ORDER IS SET BY ENTRIES IN
C     KSERVE(),RECKONED FROM THE FIRST.
C
C     ISALT- USED ONLY WHEN BACKGROUND CONCENTRATIONS OF CONSERVATIVE
C     POLLUTANTS ARE DESIRED.  ISALT=1--FLOWS (HISTORICAL OR GENERATED)
C     ARE ON THE FLOW TAPE. IN EACH TIME FRAME UNREGULATED INFLOWS INTO
C     EACH COORD. ARE CALCULATED. . SEE SUBROUTINE UNREGG). THE
C     CONCENTRATION OF THESE INFLOWS IS DEFINED BY REGRESSION ON THESE
C     FLOWS. THUS THE PROGRAM EXPECTS A SET OF REGRESSION COEFF.
      ISALT=2-- BOTH GENERATED FLOWS AND QUALITY AT GAGING AND MONITORIN
C     STATIONS ARE STORED ON TAPE. QUALITY OF ALL INFLOWS ARE COMPUTED
C     BY REGRESSION ON THE QUALITY AT THE MONITORING STATIONS.
C     THUS THE PROGRAM EXPECTS REGRESSION COEFS. RELATING CONC. AT I
C     TO CONC. AT J, WHERE J IS A MONITORING STATION.
C
C     IEVAP- EVAPORATION OF STORAGE AT RESERVOIRS OPTION KEY
C
      READ(5,90 )(NOUT( I),I=1,20)
C
C     NOO-PRINTING SUPPRESS VECTOR.
C
190   FORMAT (15I5)
      IF(IFLR)230,230,240
240   IF(IRUN-1)250,250,260
250   CALL EXIT
C
C     SUBROUTINE DATFER- DESIGN PARAMETER UPDATE - USED ONLY WHEN
C     EXECUTING MULTI-RUNS.
C
260   CALL DATFER(NA,NSEAS,CAP,S,DEAD,DEFTMP,DEFC,DEFB,NSERVE,
     1KSERVE,ITRAN,TRA DIR,ITPPIP,AVWO,SDWO,AVCONC,SDCONC,AVNEED,SDNEED,
     2CRIT,ACINT,REGCO,SESALT,TESALT)
C
C     SUBROUTINE TITLE- PRINTS BASIC CONTROL AND GEOMETRY DATA.
C
      CALL TITLE(NPOINT,NDAMS,NTESTS,NWASTE,PLACE,IRUN,NRUNS,NYRS,NWVRLS
     1,NTAPE,NSKIP,IRPAT,NTYPE, NEXT,JUNC,NA,NFEW,NSTART,NO)
      GO TO 270
C*****************
C
```

B 6

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C     ALL SUBROUTINE ARUMENTS ARE DEFINED IN SUBROUTINES.
C
C*****************
C
C     SUBROUTINE DATIN1,DATIN2,DATIN3 INPUTS ALL DATA.
C     THREE ARE NECESSARY - 360 FORTRANIV- COMPLIER CONSTRANT.
C     TABLEAUS WERE ELIMINATED AS ALTERNATIVE- CLARITY.
C
C***
C
C     NOTA BENE-
C     CONTINUE STATEMENTS ARE NEEDED TO BREAK UP LONG LISTS OF COMMENT
C     STATEMENTS. REQUIREMENT OF 360 IBM FORTRANIV.
C
C***
240   CALL TITLE(NPOINT,NDAMS,NTESTS,NWASTE,PLACE,IRUN,NRUNS,NYRS,NWVBLS
     1,NTAPE,NSKIP,IRPAT,NTYPE, NEXT,JUNC,WA,NFEW,NSTART,NO)
C
      CALL DATIN1(NDAMS,CAP,DEAD,S,DEFTRP,DEFB,DEFC,ITRDIV,ITRAN,TRADIR,
     1IPIPE,ITPRIP,NWASTE,NWVBLS,FLOMIN,FLCMIN,AVWO,SDWO,AVCONC,SDCONC,
     2NSEAS)
      CALL DATIN2(NSER,NSERVE,KSERVE,AVNEED,SDNEED,NWVBLS,CRIT,IFLOD,
     1IIPFLD,IEVAP,IDAMEV,NDAMS,IEPVEC,EVPXM,NSEAS,EVPSD,IRFEV,FACEVP,
     2ACOEVP,XCOEVP,S,DAMSS)
C
      CALL DATIN3(KEYMOD,INGRAN,MODCON,TEMR,EMIL,CONSTV,EXPV,OXYWAS,
     1OXYDAM,ISALT,ISALMP,NPOINT,REGCO,ACONT,SESALT,TESALT,NWVBLS,FLOW,
     1NGAGES)
C
C
C
C
C     SUBROUTINE SET- INITIALIZES TALLYING MATRICES, FORMS MAPS OF
C     TEST POINT AND DAMSITE INPUT ORDERING TO ACTUAL COORD. LOCATION
C     POSITIONS FLOW TAPE FOR CURRENT RUN.
C
270   CALL SET(NDAMS,NFILL,NORY,NSEAS,NWVBLS,NPOINT,AMBENT,OULMAX,OULMIN
     1,NOEFY,NOX,NOX3,DEFECH,NGAGES,NSKIP,NBINRY,NTAPE,FLOW,NTYPE,LODAM,
     2LOJUNK,DAMCON,DAMSS,DAMMAX,DAMMIN)
C
C     SUBROUTINE SET1- DETERMINES MAXIMUM NUMBER OF ITERATIONS THAT THE
C     PROGRAM WILL ATTEMPT TO SATISFY WATER USERS AND CHECKS FOR CORRECT
C     REFERENCING BETWEEN FLOW GAGES AND WATER QUALITY MONITORING STATIO
C     DETERMINES WHICH OUTPUT LINK PRECEDES ROUTING LINK.
C     INITIALIZES TALLYING MATRICES.
C
      CALL SET1(NWRIT,NSEAS,NITER,IPIPE,NSER,NSERVE,ISALT,ISALMP,KGAGE,
     1NPOINT,NOX,DEFX,YRMAX,YRC(N),MOD,INVES)
C
C     PRINTING LINK(S) CAN BE BYPASSED, BUT THE DESIRED SEQUENCE MUST
```

B 7

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C     OF THE SAME FOR ALL RUNS.
C
      IF(INVES-51280,280,290
290   WRITE(2)NSER,NYRS,NSEAS,NPOINT,IRUN,NWVALS,NDAMS
280   CONTINUE
C
C     INITIALIZE SYSTEM
C
C     INITIAL- FLAG TO SIGNAL S.R. UNREGG THAT INITIAL FLOWS AT GAGING
C     STATIONS HAVE BEEN INPUTTED AS BCD DATA.
C
      INITIAL=1
      N7=0
      IF(N0)310,310,320
310   N7=1
C
C     INITALIZES FLOWS IN SYSTEM.
C
C
C     SUBROUTINE UNREGG-FOR EACH TIME FRAME FLOWS AT ALL FLOW GAGING
C     STATIONS ARE READ IN. BY REFERENCE TO KGAGE AND SCALING BY FACTOR,
C     THE UNREGULATED OR LOCAL INFLOW INTO EACH COORD. IS CALCULATED.
C
320   CALL UNREGG(NNUMBRY,FLOW,NGAGES,NPOINT,0,FACTOR,NEXT,UNREG,NTYPE,
     1JUNC,N0,N7,KGAGE,ITAPE,INITIAL)
C
      DO 330 I=1,NPOINT
330   ORO(I)=Q(I)
C
C
C     SUBROUTINE FCH01,FCH02,FCH03 - PRINTS ALL CURRENT DESIGN PARAMETER
C
      CALL FCH01(NPOINT,KGAGE,FACTOR,CR,NDAMS,CAP,S,DEAD,DEFTMP,DEFB,
     1NFFC,NSEAS,NSER,NSERVE,KSERVE,ITROIV,LODAM,ITRAN,LOJUNK,TRADIR,
     2IPIPE,ITPPIP,IOPT)
      CALL FCH02(IEVAP,IDAMEV,NDAMS,IREEV,FACEVP,ACOEVP,XCOEVP,IEPVEC,
     1EVPAP,EVPSD,NSEAS,NWVALS,FLORAT,FLOWIN,HRASTE,AVWO,SDWO,AVCONC,
     2SDCONC,DAMSS)
      CALL FCH03(KEYROD,NPOINT,BODCON,FMIL,CONSTV,EXPV,OXYWAS,TEMR,NSEAS
     1,OXYDAM,NDAMS,INGRAN,ISALT,ACONT,REGCO,SESALT,TESALT,ISALMP,NSER,
     2AVREFD,SDREFD,NWVALS,CRIT,IFLOD,ITPFLD)
C
C
      KAPT=0
C     INEFFICIENT RESERVOIR OPERATION COUNTER
C     WRITE ITER
C     MEASURES THE EFFECTIVENESS OF RESERVOIR ALLOCATION STRADEGIES.
C     ONLY MEANINGFUL WHEN RESERVOIRS SUPPLY OR USER DEMAND(NSERVE,KSERV
C
      CALL SETTE(1)
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```
C
      INTIAL=0
      NZ=0
      FNSEAS=NSEAS
C
C     NRAN- TOTAL NUMBER OF RANDOM NUMBERS TO BE USED IN EACH TIME FRAME
C
      NRAN=(NWASTE*(1+NWVBLS))
      NRAN=NRAN+NSER+NDAMS+NPOINT
C
C     ****************************************************************
C     BEGIN SIMULATION
C
      DO 340 IY=1,NYRS
      IY=IY
      DO 350 IS=1,NSEAS
      IS=IS
C
      DO 360 IRAN=1,NRAN
      CALL CLT24(IRPAT,XXX)
C
C     SUBROUTINE CLT24- COMPUTES (NRAN) RANDOM NUMBERS FOR EACH TIME FRA
C     PROPERTIES- (0,1,N)
C
360   RN(IRAN)=XXX
C
C
C     SUBROUTINE UNREGG- COMPUTES LOCAL INFLOW INTO EACH COORD.-
C     NOTE- IF BOTH FLOWS AND QUALITY HAVE BEEN GENERATED AND ARE BEING
C     READ IN FRAME BY FRAME, THEN VECTOR FLOW WILL CONTA N BOTH FLOWS
C     AND QUALITY RECORDS.  (ISALT=2)-- SPECIAL CARE SHO LD BE TAKEN TO
C     INSURE CORRECT REFERENCING
      CALL UNREGG(NBINRY,FLOW,NGAGES,NPOINT,Q,FACTOR,NEXT,UNREG,NTYPE,
     1JUNC,NO,NZ,KGAGE,NTAPE,INTIAL)
C
C
      IF(INGRAN)370,370,380
C
C
C     SUBROUTINE SALT- COMPUTES AMBIENT CONCENTRATION OF THE LOCAL INFLO
C     FOR CONSERVATIVE POLLUTANTS.N.B.- IF ISALT=2, OR IF QUALITIES ARE
C     TO BE COMPUTED BY REGRESSION ON GENERATED VALUES AT QUALITY
C     MONITORING STATIONS, THEN THE NUMBER OF CONSERVATIVE POLLUTANTS
C     THAT CAN BE CONSIDERED EQUALS ONE. THIS CONSTRAINT IS NECESSARY
C     BECAUSE OF NUMERICAL BIASING PROBLEMS IN THE GENERATION OF THE DAT
C
380   CALL SALT(NPOINT,INGRAN,FRANK,UNREG,NTYPE,ACONT,REGCO,SESALT,
     1TESALT,ISALT,ISALMP,FLOW,RN)
C
C     WHEN ALL RESERVOIRS ONLY OPERATE BY INPUT RULES AND/OR FOR EXPLICI
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C     DIVERSIONS, THEN NITER EQUALS 1.
C     IF GREATER THAN ONE- THE ABOVE APPLIES TOGETHER WITH DOWNSTREAM
C     TARGETS  TO BE SATISFIED AND/OR CONDITIONAL DIVERSIONS TO BE MADE.
C
370   IF(NITER-1)390,390,400
C     SUBROUTINE STORER- STORES BEGINNING OF THE TIME FRAME CONDITIONS
C     FOR CERTAIN VARIABLES.
C
400   CALL STORER(NDAMS,STSAVE,S,NFIL2,NFILL,NDRY,NDRY2,NSFR,NDEF,2,
     1NDEFY,NDX2,NDX,NDX4,NDX3,QOLD2,QOLD,NWVBLS,DAMSAV,DAMCON,AMBEN2,
     1AMBENT,IS,NPOINT)
C
390   ITER=1
C
C     RETURN POINT FOR ITERATIVE ATTEMPT TO SATISFY EITHER OR BOTH
C     CONDITIONAL WATER QUALITY OR FLOW TARGET DIVERSION DEFICITS OR
C     DOWNSTREAM FLOW AUGMENTATION NEEDS.
C
410   IWASTE=0
C
C     SUBROUTINE FRAMUP - INITIALIZES WORKING MATRICES
C
      CALL FRAMUP(IS,NSEAS,NSER,YRSUM,IWATER,DEFY,FLODIR,REQU,INDAM,
     1FLOOUL,NWVBLS,NDAMS,QSUP,ITER,DEFMAX)
C
      IDAM=0
      ITEST=0
      IJUNC=0
C
C     LOCN- LOCATION OR COORD. INDEX
C     JUNK- CONFLUENCE POINT FLAG
C
      DO 420 I=1,NPOINT
420   JUNK(I)=0
C     MJUNC- JUNCTION (CONFLUENCE) POINT COUNTER
      MJUNC=0
C
C     OUT- ROUTED FLOW FROM POINT I TO POINT J.
C     THIS IS THE TRANSLATED FLOW FROM ONE COORD. TO ANOTHER DURING A
C     TIME-FRAME. IF ROUTING COEFF. (CR) = 1, THEN THE AVERAGE FLOW AT
C     POINT I WILL REACH POINT J DURING THE TIME-FRAME. THIS IMPLIES THA
C     THE AVERAGE TIME OF TRAVEL IS EQUAL OR LESS THAN THE TIME
C     INTERVAL. IF THIS IS NOT THE CASE (THIS RARELY OCCURS ), THEN THE
C     ROUTING COEFF. WILL NOT BE EQUAL TO ONE.
C     EXTREME CAUTION IS ADVISED WHEN USING NON-UNITY COEF.
C     SEE SUBROUTINE ROUTE FOR THE ROUTING COMPUTATIONS.
C
      OUT=0.0
C
C     SENSK-COUNTER TO INDICATE THAT DURING THE SECOND AND SUBSEQUENT
```

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C       ITERATIONS,INSUFFICIENT RELEASES WERE MADE BY RESERVOIRS TO
C       DOWNSTREAM USERS AND THAT STORAGE STILL REMAINS IN SOME OR ALL OF
C       RESERVOIRS SPECIFIED FOR AUGMENTATION. THE SAME HOLDS TRUE FOR
C       CONDITIONAL DIVERSIONS.
C
        SFNSK=0.0
C
C       SFPIP- KEY TO ITERATE FOR CONDITIONAL DIVERSION RELEASES.
C       SEVERAL ITERATIONS MAY BE NECESSARY BECAUSE THE DIVERSIONS MAY
C       BE ATTEMPTING TO MEET A WATER QUALITY STANDARD.
C       SIMILAR TO SFNSK
C
        SFPIP=0.0
C
C       BEGIN SEASONAL ROUTING
C
C
C       HERE THE STARTING POINT CONDITIONS ARE DEFINED.
        LOCN=NSTART
C
        CALL EXTPNT(UNREG,LOCN,KEYBOD,AMBENT,INGRAN,FRANK,BODCON,QQ)
C
C       SUBROUTINE EXTPNT- DEFINES AMBIENT CONCENTRATIONS OF THE STATE
C       FLOWS AT EXTREME POINTS ON TRIBS. OR ON MAINSTEM.
C       DEFINES SYSTEM STREAM FLOW AT EXTREME POINTS.
C
C       ****
C
C       THE GUTS OF THE ROUTING IS CENTERED ON STATEMENTS 430 AND 490.
C
C       ****
C       NT=1-TESTPOINT
C       NT=2 WASTE SITE
C       NT=2-WASTE SITE
C       NT=3-DAMSITE
C       NT=4-CONFLUENCE POINT
C       NT=5-END POINT
C       THE APPROPRIATE SUBROUTINE IS CALLED AND THEN ROUTING TAKES PLACE.
C       THE JTH COORD. TO BE CONSIDERED AFTER THE ITH, IS DEFINED BY
C       NEXT I  IN SUBROUTINE ROUTE.
C       THE EXCEPTION OCCURS AT A CONFLUENCE POINT. - SEE SUBROUTINE FJUNC
C
430     NT=NTYPE(LOCN)
        GO TO (440,450,460,470,480),NT
C
C       WASTE POINT COMING UP
C
450     IWASTE=IWASTE+1
C
C
```

```
C      SUBROUTINE WASTE- ALL THE POLLUTANTS ARE ADDED AND MIXED WITH THE
C      STREAMFLOW AND QUALITY.  COMPLETE AND SPA.IALLY INSTANTANEOUS
C      MIXING IS ASSUMED.
C
       CALL WASTE(NWVBLS,LOCN,IS,UNREG,OUT,AVWQ,SDWQ,RN,NWASTE,FLOMIN,
      1FLCMIN,AVCONC,SDCONC,QQ,AMBENT,NPOINT,IWASTE)
C
C
C
C      SUBROUTINE ROUTE- 1-ROUTES SYSTEM FLOW TO NEXT DOWNSTREAM COORD.,
C      2- ADDS LOCAL INFLOW AT NEXT COORD.,3- BLENDS THE BACKGROUND
C      QUALITY OF THE LOCAL INFLOW WITH THAT OF THE ROUTED SYSTEM FLOW,
C      4- IF A DEGRADABLE POLLUTANT IS SPECIFIED, THEN ITS CONCENTRATION
C      IS DEGRADED ENROUTE.
C
490    CALL ROUTE(NEXT,LOCN,OUT,OULD,CP,QQ,UNREG,NWVBLS,KEYBOD,CONSTV,
      1EXPV,TEMR,OXYWAS,AMBENT,BODCON,INGRAN,FRANK,FMIL,IS)
C
       GO TO 430
460    IDAM=IDAM+ 1
C
C
C      DAMSET AND DAMGO MAKES RELEASES.
C      RELEASES INCLUDE, 1- UNAVOIDABLE SPILL,2-EXPLICIT TRANSBASIN
C      DIVERSIONS,3- RELEASES DEFINED BY INPUT RULE CURVE, 4-CONDITIONAL
C      DIVERSIONS, 5- CONDITIONAL DOWNSTREAM AUGMENTATION.
C      STORAGE IN ANY RESERVOIR CAN BE DEPLETED OR AUGMENTED BY AN EVAP.
C      OPTION. EVAPORATION(+OR-) TAKES PLACE BEFORE ANY RELEASES ARE
C      COMPUTED.
C
       CALL DAMSET(AVAIL,S,IDAM,QQ,IS   ,NWVBLS,AMBENT,DAMCON,KEYBOD,
      1NSEAS,TEMR,OXYDAM,LODAM,IEVAP,IDAMEV,IRFEV,NWASTE,NSER,RN,FACEVP,
      1EVPXM,EVPSD,ACOEVP,XCOEVP,CAP)
       CALL DAMGO(AVAIL,S,IDAM,ITRDIV,IS,ITRAN,DEAD,CAP,FLODIR,NWVBLS,
      1FLOOUL,DAMCON,DEFTMP,DEFB,DEFC,IPIPE,ITPPIP,DSUP,REDU,LODAM,QQ,
      2NFILL,NDRY,TRADIR,INDAM)
C
       GO TO 490
C
C      USE OR TEST POINTS COMING UP
C      THIS IS A JUNCTION POINT
C
470    JUNK(LOCN)=JUNK(LOCN)+1
       IF (JUNK(LOCN)-1)500,500,510
500    MJUNC=MJUNC+1
C      SUBROUTINE FJUNC- 1- STORES STREAMFLOW AND QUALITY WHEN FIRST
C      ENCOUNTERED. 2- MIXES STREAMFLOW AND QUALITY OF TWO TRIBS. WHEN
C      RE-ENCOUNTERED.
C
C
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C     JUNC- CONTAINS LOCATION OF EXTREME POINT ON OPPOSITE TRIBUTARY
C     THAT IS TO BE CONSIDERED NEXT.
C
      CALL FJUNC(JUNK,LOCN,OUTSAV,QQ,OUT,NWVBLS,AMSAVE,AMBENT)
C
C
C     T IS BLOCK COVERS THE FIRST PASS
C
      LOCN=JUNC(MJUNC)
C
C     INITIALIZING CONCENTRATIONS FROM UNREGULATED AT NEXT EXTREME PT.
C
C
      CALL EXTPNT(UNREG,LOCN,KEYBOD,AMBENT,INGRAN,FRANK,BODCON,QQ)
C
      GO TO 430
C
C     SECOND PASS
C
510   IJUNC=IJUNC+1
      IJUNK=IJUNC+ITEST
C
      CALL FJUNC(JUNK,LOCN,OUTSAV,QQ,OUT,NWVBLS,AMSAVE,AMBENT)
      JUNK(LOCN)=0
C
C
C     NOTE THAT ALL JUNCTION POINTS ARE CONSIDERED TEST POINTS, BUT THE
C     TESTING IS PERFORMED ONLY AFTER THE JUNCTION POINT HAS BEEN
C     ENCOUNTERED TWICE. THIS DICTATES THE ARRANGEMENT OF TEST POINT
C     TARGET VALUE INPUT. (SEE AVNEED,SDNEED)
C
      GO TO 520
C
C     TEST POINT BUT NOT A JUNCTION
C
440    TEST=ITEST+1
       JUNK=ITEST+IJUNC
C
C
C
C     SUBROUTINE TESDIR-MIXES AND BLENDS CONDITIONAL AND EXPLICIT
C     DIVERSIONS AT TEST AND JUNCTION POINTS.
C
520   CALL TESDIR(ITRDIV,IPIPE,FLODIR,FLOQUL,NWVBLS,LOCN,QQ,AMBENT)
C
C     SUBROUTINE TESTTP-CHECKS WATER QUALITY STANDARDS AND INSTREAM FLOW
C     TARGETS. COMPUTES NESSARY AUGMENTATION IF DEFICIENT.  TALLIES
C     MISSES.  FIVE WATER QUALITY STANDARDS MAY BE TESTED.  A FLOW
C     REQUIREMENT CAN ALSO BE TESTED.  THIS REQUIREMENT COULD BE FOR ANY
C     ONE OF THE FOLLOWING-1-MUNICIPAL AND INDUSTRIAL WATER DEMAND.
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C      (EITHER STATED AS AN INSTREAM FLOW REQUIREMENT OR AS A DEPLETION)
C      2-FLOW NECESSARY TO MAINTAIN A CERTAIN LEVEL OF DISSOLVED OXYGEN.
C      3-FLOWS FOR FISH SPAWNING AND PASSAGE. 4- IRRIGATION WATERS.
C      5- NAVIGATION  . 7- FLOOD CONTROL (SIMPLY MONITORS FLOWS ABOVE A
C      CERTAIN LEVEL- CHANNEL CAPACITY) .  8- WHITE-WATERING AND ESTHETIC
C
C
       CALL TESTTP(DEFMAX,NHVBLS,AMBENT,OQ,CRIT,DEFY,IS,IWATER,NDX,NWASTE
      1,IJUNK,AVNEED,SDNEED,LOCN,IFLOD,ITPFLD,NDX3,RN,NPOINT,NDEFY)
C
C      SUBROUTINE TESCHK- TALLIES SFNSK AND SFPIP FOR ITERATIVE SIGNAL.
C
       CALL TESCHK(DEFMAX,IJUNK,NSERVE,IFLOD,ITPFLD,KSERVE,INDAM,IPIPE,
      1ITPPIP,NDAMS,SFNSK,SFPIP,LODAM,LOCN)
C
       GO TO 490
C
C      CHECKING FLAGS FOR IF ADDITIONAL PASSES ARE NECESSARY.
C
C
C      NITER- TOTAL NUMBER OF TIMES PROGRAM CAN ITERATE (UP TO 6) DURING
C      DURING ANY TIME FRAME. DETERMINED IN SUBROUTINE SET1.
C
C      NITER = 1. ONLY FIXED RULES OR EXPLICIT DIVERSIONS HAVE BEEN
C      SPECIFIED. NO ADDITONAL PASSES.
C
480    IF(NITER-1)530,530,535
C
C      CONDITIONAL DIVERSION KEY.
C
535    IF(IPIPE)540,540,545
545    IF(SFPIP)550,550,555
C
C      CONDITIONAL DIVERSIONS HAVE BEEN SATISFIED.
C
550    ITER=3
C
C      DOWNSTREAM FLOW REQD. KEY.
C
540    IF(SFNSK)530,530,555
555    IF(ITER-NITER)560,560,570
C
C      SPECIFIED RESERVOIRS STILL HAVE AVAIL STORAGE FOR SATISFYING
C      NEEDS. POOR OPERATIONS POLICY COUNTER.
C
570    KANT=KANT + 1
       GO TO 530
560    ITER=ITER+1
C
C      SUBROUTINE SEARCH- DETERMINES 1)-- RELEASES FOR SATISFYING
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C     CONDITIONAL DIVERSION NEEDS FROM THE SPECIFIED RESERVOIRS.
C     THESE ARE RELEASED FROM THE RESERVOIRS DURING THE NEXT ITERATION.
C     2)-- RELEASES FOR SATISFYING PRE-SPECIFED DOWNSTREAM WATER USERS.
C
C     PRESPECIFIED IMPLIES THAT A WATER USER IS TO RECEIVE AUGMENTATION
C     WATERS FROM A SET OF RESERVOIRS (KSERVE) IF THE SUM OF A- NATURAL
C     LOCAL INFLOWS, B-EXPLICIT DIVERSIONS (EITHER TO THE USER OR VIA
C     UPSTREAM USERS), C- RELEASES BY SOME UPSTREAM RESERVOIR(S) OPERATE
C     BY SOME INPUT RULE CURVES(DEFTEMP,DEFC,DEFB), AND D-CONDITIONAL
C     DIVERSIONS TO UPSTREAM USERS IS LESS THAN THE USER DEMAND FLOW
C     OR THE RESULTANT WATER QUALITY IS GREATER THAN ANY OF THE FIVE
C     POSSIBLE WATER QUALITY STANDARDS. AGAIN THESE RELEASES ARE MADE
C     DURING THE NEXT ITERATION.
C
C
      CALL SEARCH(IPIPE,ITER,NSTART,NPOINT,NTYPE,DEFMAX,NDAMS,
     1ITPPIP,S,DEAD,IWATER,OSUP,JUNK,NEXT,SFNSK,ITPFLD,NSERVE,KSERVE,
     2LODAM,REQU,IOPT,JUNC,LOJUNK,IFLOD)
C
C
C     SUBROUTINE RESTOR- RE-DEFINITION OF CERTAIN STATE PARAMETERS FOR
C     NEXT ITERATION.
C
C
      CALL RESTOR(NDAMS,STSAVE,S,NFILL2,NFILL,NDRY,NDRY2,NSER,NDEF 2,
     1NDEFY,NDX2,NDX,NDX4,NDX3,QOLD2,QOLD,NWVBLS,DAMSAV,DAMCON,AMBEN2,
     1AMBENT,IS,NPOINT)
C
      GO TO 410
C
C     BOOKKEEPING SECTION
C
C
C     SUBROUTINE TAPOT1- STORES TERMINAL CONDITIONS OF IMPORTANT
C     PARAMETERS FOR EACH TIME FRAME- E.G., TERMINAL STORAGE IN ALL
C     DAMS, SYSTEM QUALITY AT ALL TEST POINTS, DEFICIENCIES AND TYPE,
C     ETC., ON MAGNETIC TAPE FOR SUBSEQUENT STATISTICAL MANIPULATION.
C     ALSO FINDS THE RANGE( MAX. , MIN. ) OF CERTAIN PARAMETERS.
C     RESPONSE DATA IS OUTPUTTED DEPENDING UPON VALUE OF INVES.
C
C
  530 CALL TAPOT1(NWVBLS,NSER,DEFECH,DEFY,DEFX,YRSUM,IS,NSEAS,QQ,AMBENT,
     1S,NDAMS,NPOINT,QQX,LOJUNK,QULMAX,QULMIN,LODAM,DAMCON,DAMMAX,DAMMIN
     2,YRMAX,DEFMAX,YRCOU,INVES)
C
  350 CONTINUE
  340 CONTINUE
C     ****************************************************************
C
C     END OF SIMULATION
```

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C
C     ***************************************************************
C
C
      CALL SLITE(0)
C
C
C     SUBROUTINE WRITOT- PRINTS NUMBER OF SEASONAL MISSES + PROB. FOR
C     EACH RUN.
C
      CALL WRITOT(IRUN,NYRS,NSEAS,KANT,NWRIT,LOJUNK,NDEFY,NDX3,NSER,
     1YPC(N))
C
      IF(INVES-5)585,585,595
595   IS=13
C
C     END OF RUN
C
      WRITE(2)IS
C     SUBROUTINE TAPOT2- STORES MAXIMUM AND MINIMUM VALUES OF CERTAIN
C     PARAMETERS THAT WILL BE SUBSEQUENTLY USED IN THE PROCESSING OF
C     SYSTEM RESPONSE DATA.
C
      CALL TAPOT2 (NWVBLS,OCX,NPOINT,NSEAS,LOJUNK,QULMAX,QULMIN,NSER,
     1CAP,DEAD,DEFX,NDRY,NFILL,LODAM,NDAMS,NOD,NDEFY,YRMAX,NDX,DEFECH,
     2DAMMAX,DAMMIN)
C
C     LOOPING ON RUNS.
C
585   IRUN=IRUN+1
      GO TO 160
170   IS=14
      WRITE(2)IS
C
C     NOTE CAREFULLY, THE KEYING OF IS . IS=13 END OF RUN,IS=14-END
C     OF ALL RUNS
C
C     DATA PROCESSING LINK
C
      REWIND 2
      REWIND 3
      REWIND 10
      IF(NRINKY)580,580,590
590   REWIND NTAPE
580   CONTINUE
C     ***************************************************************
C
C     END OF ROUTING LINK
C
C     ***************************************************************
```

```
C
      RETURN
      END
      SUBROUTINE TITLE(NPOINT,NDAMS,NTESTS,NWASTE,PLACE,IRUN,NRUNS,NYRS,
     1NWVBLS,NTAPE,NSKIP,IRPAT,NTYPE,NEXT,JUNC,WA,NFEW,NSTART,ND)
      DIMENSION NTYPE(50),NEXT(50),JUNC(10),WA(18,5),PLACE1(18)
     1,PLACE(18)
C
C     ARGUMENT DEFINITIONS
C
C     NPOINT- NUMBER OF COORD. IN SYSTEM
C
C     NDAMS- NUMBER OF DAMS IN SYSTEM
C
C     NTEST- NUMBER OF INPUT TEST POINTS (EXCLUDES JUNCTION POINTS)
C
C     NWASTE- NUMBER OF WASTE SITES IN SYSTEM
C
C     PLACE- RIVER BASIN TITLE
C
C     IRUN- RUN INDEX
C
C     NRUNS- TOTAL NUMBER OF RUNS. (PLANS BEING INVESTIGATED.)
C
C     NYRS- NUMBER OF YEARS OF ROUTING
C
C     NWVBLS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFIED)
C
C     NTAPE- FLOW AND QUALITY LOGICAL TAPE NUMBER. BCD-5, BINARY-OPEN.
C
C     NSKIP-NUMBER OF YEARS FLOW TAPE IS TO BE SKIPPED FORWARD.
C
C     IRPAT- RANDOM NUMBER GENERATOR TRIGGER.
C
C     NTYPE- NUMERIC DESCRIPTION OF EACH COORD.
C
C     NEXT- (NAMED) DOWNSTREAM COORD. OF ITH COORD - PROCEEDING IN NUMERIC
C     ORDER.
C
C     JUNC-COORD. OF EXTREME POINT ON TRIB. TO WHICH ROUTING WILL
C     PROCEED WHEN A JUNCTION POINT IS ENCOUNTERED.
C
C     WA-DESCRIPTION CARDS FOR PARAMETER UPDATE USING OPTION- NFEW=1
C
C
C     NFEW- DESIGN PARAMETER UPDATE OPTION KEY.
C
      WRITE(6,1)
    1 FORMAT (1H1S0X,13HMODEL NETWORK////)
      WRITE (6,2)PLACE,IRUN,NRUNS,NYRS,NWVBLS,NTAPE,NSKIP,IRPAT,NSTART,
```

```
      END
2     FORMAT (1H1)8A4///1H03HRUNI5,2X,2HOFI5///1H0I10,2X,15HYEARS OF REC
     1ORD,I5,2X,16HWASTE VARIABLES //1H 4HTAPEI3,2X,13HTO BE SKIPPEDI6,2
     1X,7HRECORDS//1H    22X,31HRANDOM NUMBER GENERATOR TRIGGER,2X,I12/
     1IH0,24HSTARTING POINT IN SYSTEM,2X,I4,10X,23HUNREGULATED FLOW OPTIO
     1N,2X,I5)
      WRITE (6,3)NPOINT,NDAMS,NTESTS,NWASTE
3     FORMAT (1H0/1H I6,2X,6HPOINTSI10,2X,4HDAMSI10,2X,5HTESTSI10,2X,6HW
     1ASTES//////1H010HCOORDINATE,5X,4HTYPE5X,8HSUM TYPE,5X,13HNEXT LOCA
     1TION,4X,26HSTARTING POINT OF NEW BRANCH///)
      IU=0
      IW=0
      ID=0
      IJ=0
      DO 4 I=1,NPOINT
      NT=NTYPE(I)
      GO TO(5,6,7,8,9),NT
5     IU=IU+1
      WRITE(6,10)I,IU,NEXT(I)
10    FORMAT (1H I5,10X,4HTEST,5X,I4,9X,I5)
      GO TO 4
6     IW=IW+1
      WRITE (6,11)I,IW,NEXT(I)
11    FORMAT (1H I5,9X,5HWASTE,5X,I4,9X,I5)
      GO TO 4
7     ID=ID+1
      WRITE (6,12)I,ID,NEXT(I)
12    FORMAT (1H I5,11X,3HDAM,5X,I4,9X,I5)
      GO TO 4
8     IJ=IJ+1
      WRITE (6,13)I,IJ,NEXT(I),JUNC(IJ)
13    FORMAT (1H I5,5X,5HMERGE,5X,I4,9X,I5,12X,I4)
      GO TO 4
9     WRITE (6,14)I
14    FORMAT (1H I5,11X,3HEND)
4     CONTINUE
      IF (NDPRNT)15,15,16
15    WRITE(6,17)
17    FORMAT (1H120X,30HDESCRIPTION OF EACH COORDINATE///)
      DO 18 I=1,NPOINT
      READ (5,19 )(PLACE1(J),J=1,18)
19    FORMAT (18A4)
18    WRITE (6,20 )I,(PLACE1(K),K=1,18)
20    FORMAT (1H 10X,I5,5X,18A4)
      GO TO 21
16    WRITE(6,22)IRUN
22    FORMAT (1H120X,24HCOMMENTS SPECIFIC TO RUNI4///)
      DO 23 I=1,5
23    WRITE(6,24)(NA(J,I),J=1,18)
24    FORMAT (1H 20X,18A4)
```

```
21    RETURN
      END
C
      SUBROUTINE DATIN1(NDAMS,CAP,DEAD,S,DEFTMP,DEFB,DEFC,ITRDIV,ITRAN,
     1TRADIR,IPIPE,ITPPIP,NWASTE,NWVBLS,FLOMIN,FLCMIN,AVWQ,SDWQ,AVCONC,
     2SDCONC,NSEAS)
      DIMENSION CAP(15),DEAD(15),S(15),DEFTMP(15,12),DEFB(15,12),DEFC(15
     1,12),ITRAN(15),TRADIR(15,12),ITPPIP(15),FLOMIN(10),FLCMIN(10,5),
     2AVWQ(10,1,12),SDWQ(10,1,12),AVCONC(10,5,12),SDCONC(10,5,12)
C
C     ARGUMENT DEFINITIONS.
C
C     NDAMS- NUMBER OF DAMS IN SYSTEM
C
C     CAP- CAPACITY OF EACH RESERVOIR (UNITS MUST BE INPUT COMPATIBLE
C     WITH STREAMFLOW,WASTE FLOW ,TARGETS,ETC
C
C     DEAD- MINIMUM POOL STORAGE IN EACH RESERVOIR.
C     E.G. VOLUME OF STORAGE BELOW OUTLET IPIPE, RECREATIONAL POOL VOL.
C
C     S- STARTING STORAGE IN EACH RESERVOIR- RECKONED FROM ZERO.
C
C     GENERAL FORM OF INPUT RESERVOIR RULE CURVES.
C     DRAFT(IS)=A(IS) + B(IS)*INFLOW(IS) + C(IS)* STORAGE(IS-1)
C
C     DEFTMP = A. WHEN B(IS) AND C(IS) ARE ZERO AND A(IS) IS LESS THAN
C     ZERO, THEN A(IS) IMPLIES A FRACTIONAL CAPACITY VOLUME RULE.
C     COMMONLY USED AS A FLOOD CONTROL OR RECREATIONAL POOL LEVEL RULE.
C
C     DEFB = B
C
C     DEFC= C
C
C     USE OF THE GENERAL RULES IS A VERY CONVENIENT MEANS OF MAPPING
C     THE OPERATION OF EXISTING RESERVOIRS INTO A SYSTEM. COEF. ARE
C     DERIVED FROM LEAST-SQUARES OF EXISTING DATA.
C
C     ITRDIV- EXPLICIT DIVERSION KEY
C
C     ITRAN-LOCATION OF THE TEST POINT TO WHICH DAM (I) IS TO DELIVER
C     WATER.  THIS IS THE EXPLICIT DIVERSION OPTION.  DIMENSION OF ITRAN
C     IS 15.
C
C     TRADIR- SEASONAL EXPLICIT DIVERSION QUANTITY FOR THE ITH DAM.
C     INDEX I IS THE ORDER IN WHICH THE DAMSITES APPEAR IN THE ROUTING.
C
      CONTINUE
C     IPIPE- CONDITIONAL DIVERSION KEY
C
C     ITPPIP- COORD. OF TEST POINT THAT THE ITH DAM IS TO MAKE A
```

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C       CONDITIONAL DIVERSION FOR WATER QUALITY OR FLOW REQUIREMENT
C       DEFICIENCY.
C       INDEX I IS THE ORDER IN WHICH THE DAMSITES APPEAR IN THE ROUTING.
C
C       NWASTE- NUMBER OF WASTE SITES IN SYSTEM
C
C       NWVBLS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,
C       UNSPECIFIED)
C
C       FLOMIN- MINIMUM WASTE FLOW AT WASTE SITE J- TIME INVARIANT
C
C       FLCMIN- MINIMUM WASTE WEIGHT- SITE I POLLUTANT J-  TIME INVARIANT
C       THESE TWO CONSTRAINTS ARE USED AS AN LOWER ENVELOPE FOR A STOCHAST
C       VARIATION OF WASTE VOLUME INPUT AND WASTE WEIGHT INPUT
C
C       AVWO- MEAN WASTE VOLUME OF ALL POLLUTANTS AT SITE(IWASTE),SEASON(I
C
C       SDWO- STD. DEV. WASTE VOLUME AT WASTE SITE(IWASTE),SEASON(IS)
C
C       AVCONC- MEAN POLLUTANT WEIGHT,SITE(IWASTE),POLLUTANT(NW),SEASON(IS
C
C       SDCONC-STD. DEV. POLLUT. WT., SITE(IWASTE),POLLUT.(NW) SEASON(IS)
C
C
C       NOTE. THE IMPLIED WT. UNITS FOR AVCONC AND SDCONC ARE THE FLOW OF
C       AVWO(AVERAGE WASTE FLOW RATE OVER TIME FRAME) TIMES CONCENTRATION.
C
C       NSEAS- NUMBER OF SEASONS ( TIME FRAMES PER YEAR)
C
 1      FORMAT(10I5)
 2      FORMAT(5F10.0)
 3      FORMAT(6F10.0)
        IF(NDAMS)4,4,5
 5      READ(5,2)(CAP(I),I=1,NDAMS)
        READ(5,2)(DEAD(I),I=1,NDAMS)
        READ(5,2)(S(I),I=1,NDAMS)
        DO 6 I=1,NDAMS
        READ(5,3)(DEFTMP(I,J),J=1,NSEAS)
        READ(5,3)(DEFB(I,J),J=1,NSEAS)
 6      READ(5,3)(DEFC(I,J),J=1,NSEAS)
        IF(ITRDIV)7,7,8
 8      READ(5,1)(ITRAN(I),I=1,NDAMS)
        DO 9 I=1,NDAMS
 9      READ(5,3)(TRA DIR(I,J),J=1,NSEAS)
 7      IF(IPIPE)4,4,10
 10     READ(5,1)(ITPPIP(I),I=1,NDAMS)
 4      IF(NWASTE)11,11,12
 12     IF(NWVBLS)11,11,13
 13     READ(5,2)(FLOMIN(K),K=1,NWASTE)
        DO 14 K=1,NWASTE
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```
14    READ(5,2)(FLCMIN(K,I),I=1,NWVBLS)
      DO 15 I=1,NWASTE
      READ(5,3)(AVWQ(I,1,K),K=1,NSEAS)
      READ(5,3)(SDWQ(I,1,K),K=1,NSEAS)
      DO 15 J=1,NWVBLS
      READ(5,3)(AVCONC(I,J,K),K=1,NSEAS)
15    READ(5,3)(SDCONC(I,J,K),K=1,NSEAS)
11    RETURN
      END
      SUBROUTINE DATIN2(NSER,NSERVE,KSERVE,AVNEED,SDNEED,NWVBLS,CRIT,
     1IFLOD,ITPFLD,IEVAP,IDAMEV,NDAMS,IEPVEC,EVPXM,NSEAS,EVPSD,IRFEV,
     2FACEVP,ACOEVP,XCOEVP,S,DAMSS)
      DIMENSION NSERVE(25),KSERVE(25,10),AVNEED(25,12),SDNEED(25,12),
     1CRIT(25,5,12),ITPFLD(25),IDAMEV(15),EVPXM(3,12),EVPSD(3,12),
     2IRFEV(15),FACEVP(15),ACOEVP(15),XCOEVP(15),S(15),DAMSS(15,5)
C
C     ARGUMENT DEFINITIONS.
C
C
C     NSER- NUMBER OF TEST AND JUNCTION POINTS IN SYSTEM
C
C     NSERVE- NUMBER OF DAMS TO MAKE AUGMENTATIONS FOR WATER USERS AT
C     TEST AND JUNCTION POINTS.  THESE ARE UPSTREAM FIRST TIER DAMS.
C     NOTE. THE DAMS SPECIFIED FOR THIS FUNCTION MAY BE RELEASING WATERS
C     FOR EXPLICIT TRANSBASIN DIVERSIONS, RULE CURVES, AND FOR
C     CONDITIONAL DIVERSIONS.
C
C     KSERVE-LOCATIONS OF THE RESERVOIRS SERVING TEST AND JUNCTION POINT
C     THESE ARE COORD. LOCATIONS. LIMITED TO 10 RESERVOIRS.
C     FOR IOPT=1 OR 2 THE ORDER IN WHICH DAM COORD. ARE ENTERED MAKES NO
C     DIFFERENCE. FOR IOPT=3, THE INPUT ORDER FOR EACH TEST AND JUNCTION
C     POINT IS CRUCIAL. SEE MAIN PROGRAM FOR NOTES.
C
C     AVNEED- MEAN FLOW REQUIREMENT AT TEST SITE(IJUNK),SEASON(IS)
C
C     SDNEED-STD. DEV. OF FLOW REQUIREMENT AT TEST SITE(IJUNK),SEASON(IS
C
C     CRIT-WATER QUAL. STANDARD FOR TEST SITE(IJUNK),POLLUTANT(NW),
C     SEASON(IS)- STD. ORDER MUST BE SAME AS POLLUTANT ORDER.
C
C     IFLOD- CHANNEL CAPACITY MONITORING AT TEST POINT KEY
C
C     ITPFLD- FLOOD MONITORING OPTION AT TESTPOINTS. CHECKS FOR EXCESS
C     FLOW RATHER THAN DEFICIENT FLOW . TARGET FLOWS WILL USUALLY BE
C     CHANNEL CAPACITIES. ENTERED IN AVNNEED.
C     INPUT ENTRY IS ORDER IN WHICH THE PROGRAM ENCOUNTERS TEST POINTS.
      CONTINUE
C
C     IEVAP- EVAPORATION OF RESERVOIR STORAGE KEY
C
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C     IDAMEV- RESERVOIR BY INPUT ORDER WHOSE STORAGE IS TO BE EITHER
C     DEPLETED OR AUGMENTED BY EVAPORATION(+OR-) IN THE ROUTING.
C
C     NDAMS- NUMBER OF RESERVOIRS IN THE SYSTEM.
C
C     IEPVEC- NUMBER (EQUAL OR LESS -3) OF REGIONAL SEASONAL EVAPORATION
C     VECTORS.UNITS MUST BE MADE CONSISTENT-A PRIORI.
C
C     EVPXM-SEASONAL(IS) MEAN EVAPORATION RATE , ITH VECTOR
C
C     NSEAS- NUMBER OF SEASONS PER YEAR.
C
C     EVPSD- SEASONAL(IS) STD. DEVNS. OF EVAPORATION RATE, ITH VECTOR
C
C     IRFEV- MAP RELATING EACH DAM(INPUT ORDER) TO REGIONAL EVAP. VEC.
C
C     FACEVP-FACTOR TO SCALE THE REGIONAL EVAPORATION RATE TO THAT AT
C     THE DAMSITE. NOTE ENTRY IS DAM INPUT ORDER.
C
C     ACOEVP- CONSTANT IN LINEAR EQU. RELATING AREA TO VOLUME FOR
C     EACH DAMSITE. OTHER FUNCTIONS CAN BE USED IF NEED BE.
C
C     XCOEVP- SLOPE FOR LINEAR EQU. RELATING AREA TO VOLUME. (EACH DAM)
C
C     DAMSS- CONCENTRATION (NW) FOR DAMS WITH STARTING STORAGE -NONZERO.
C     ENTRY IS BY DAM ORDER WITH NONZERO STORAGE. SAME FOR EACH RUN.
C
C     S- STARTING STORAGE IN EACH OF THE RESERVOIRS.
C
 1    FORMAT(10I5)
 2    FORMAT(5F10.0)
 3    FORMAT(6F10.0)
      IF(NSER)4,4,5
 5    READ(5,1)(NSERVE(I),I=1,NSER)
      DO 6 I=1,NSER
      NS=NSERVE(I)
      IF(NS)6,6,7
 7    READ(5,1)(KSERVE(I,K),K=1,NS)
 6    CONTINUE
      DO 8 I=1,NSER
      READ(5,3)(AVNEED(I,J),J=1,NSEAS)
      READ(5,3)(SDNEED(I,J),J=1,NSEAS)
      IF(NWVBLS)8,8,10
 10   READ(5,3)((CRIT(I,J,K),K=1,NSEAS),J=1,NWVBLS)
 8    CONTINUE
      IF(IFLOD)4,4,11
 11   READ(5,1)(ITPFLO(I),I=1,NSER)
 4    IF(IEVAP)12,12,13
 13   READ(5,1)(IDAMEV(I),I=1,NDAMS)
      READ(5,1)IEPVEC
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      DO 14 I=1,IEPVEC
      READ(5,3)(EVPXM(I,K),K=1,NSEAS)
 14   READ(5,3)( EVPSD(I,K),K=1,NSEAS)
      READ(5,1)(IRFEV(I),I=1,NDAMS)
      READ(5,2)(FACEVP(I),I=1,NDAMS)
      READ(5,2)(ACOEVP(I),I=1,NDAMS)
      READ(5,2)(XCOEVP(I),I=1,NDAMS)
 12   IF(NWVBLS)15,15,16
 16   DO 17 KJ=1,NDAMS
      IF(S'KJ))18,18,19
 19   READ(5,2)(DAMSS(KJ,NW),NW=1,NWVBLS)
      GO TO 17
 18   DO 20 NW=1,NWVBLS
 20   DAMSS(KJ,NW)=0.0
 17   CONTINUE
 15   RETURN
      END
      SUBROUTINE DATIN3(KEYBOD,INGRAN,BODCON,TEMR,FMIL,CONSTV,EXPV,
     1OXYWAS,OXYDAM,ISALT,ISALMP,NPOINT,REGCO,ACONT,SESALT,TESALT,
     2NWVBLS,FLOW,NGAGES)
      DIMENSION BODCON(50),TEMR(12),FMIL(50),CONSTV(50),EXPV(50),
     1OXYWAS(50),OXYDAM(15),ISALMP(50),REGCO(5,50),ACONT(5,50),SESALT(
     25,50),TESALT(5,50) ,FLOW(50)
C
C     ARGUMENT DEFINITIONS.
C
C     KEYBOD- DEGRADABLE POLLUTANT KEY
C
C     INGRAN- NUMBER OF CONSERVATIVE POLLUTANTS
C
C     NPOINT- NUMBER OF COORD. IN SYSTEM
C
C     BODCON- BACKGROUND CONCENTRATION OF DEGRADABLE POLLUTANT(KEYBOD=1)
C     FOR LOCAL INFLOWS INTO EACH COORD.- TIME-INVARIANT.
C
C     TEMR- MEAN SEASONAL TEMPERATURE (C)- FOR BASIN- SPACE-INVARIANT.
C
C     FMIL- RIVER MILES BETWEEN EACH COORD. JTH ENTRY IS MILES BETWEEN
C     ITH AND (I+1)TH COORDS.
C
C     CONSTV-CONSTANT IN EXPON. EQU. RELATING VELOCITY TO FLOW FOR EACH
C     COORD.-JTH ENTRY FOR ITH AND(I+1)TH COORD.
C
C     EXPV- SLOPE IN EXPON. EQU. RELATING VELOCITY TO FLOW.
C
C     OXYWAS- DECAY COEF. FOR DEGRAD.POLL. (LOG10-20 DEG. CENT)FOR ALL
C     COORD.
C
C     OXYDAM- DECAY COEF. FOR DAMSITES. (LOG10-20 DEG. CENT.)
C
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C       REGCO- UNDER OPTION ISALT=1- SLOPE OF EXPON. EQ.  RELATING CONCEN.
C       OF THE ITH CONSERVATIVE POLLUTANT TO LOCAL INFLOW FOR EACH COORD.
C       REGCO- UNDER OPTION ISALT=2- SLOPE OF LINEAR EQ.  RELATING CONCEN.
C       OF THE ITH COORD. TO A SPECIFIED QUALITY MONITORING STATION (ISALM
        CONTINUE
C
C       ACONT- CONSTANT IN THE OPTIONAL EQUATIONS NOTED IN  REGCO.
C
C       SESALT- UNDER OPTION ISALT=1- UPPER LIMIT OF CONCENTRATION FOR THE
C       ITH CONSERVATIVE POLL. AT THE JTH COORD.
C       SESALT- UNDER OPTION ISALT=2- STD. ERR. OF ESTIMATE OF REGRESSION
C       EQ. RELATING CONCENTRATION AT ITH COORD. TO KTH MONITORING STATION
C       A RANDOM COMPONENT PROPOR. TO STD. ERR. EST. WILL BE ADDED TO
C       THE REGRESSED QUALITY.
C
C       TESALT-FOR OPTION ISALT=1- LOWER LIMIT OF CONCENTRATION FOR THE
C       ITH CONSERVATIVE POLLUT. AT THE JTH COORD.
C       TESALT- ISALT=2 -- NOT USED.
C       NOTE-OPTION ISALT=1,TESALT AND SESALT FORM BOUNDS TO EXPON. EQ.:S.
C
C       ISALMP- UNDER OPTION ISALT=2- MAP RELATING ITH COORD. TO THE JTH
C       WATER QUALITY MONITORING STATION. THSES SIMULATED VALUES WILL BE
C       INPUTTED IN (FLOW)- NO ENTRY IN KGAGE AND ISALMP ARE THE SAME.
C
C       NWVBLS- NUMBER OF POLLUTANTS
C
C
C       FLOW- INITIAL FLOWS AT ALL GAGING STATIONS.
C
C
C       NGAGES- NUMBER OF GAGES
C
1       FORMAT(10I5)
2       FORMAT(5F10.0)
3       FORMAT(6F10.0)
        IF(NWVBLS)4,4,5
4       KEYBOD=0
        INGRAN=0
        GO TO 6
5       READ(5,1)KEYBOD,INGRAN
        IF(KEYBOD)7,7,8
8       READ(5,2)(BODCON(I),I=1,NPOINT)
        READ(5,3)(TEMK(I),I=1,NSEAS)
        READ(5,2)(FAIL(I),I=1,NPOINT)
        READ(5,2)(CONSIV(I),I=1,NPOINT)
        READ(5,2)(EXPV(I),I=1,NPOINT)
        READ(5,2)(OXYWAS(I),I=1,NPOINT)
        READ(5,2)(OXYDAM(I),I=1,NDAMS)
7       IF(INGRAN)6,6,9
9       IF(ISALT-1)10,10,11
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11    IF(INGRAN)12,12,13
13    CALL EXIT
12    READ(5,1)(ISALMP(I),I=1,NPOINT)
10    DO 14 I=1,NPOINT
      READ(5,2)(ACONT(ING,I),ING=1,INGRAN)
      READ(5,2)(REGCO(ING,I),ING=1,INGRAN)
      READ(5,2)(SESALT(ING,I),ING=1,INGRAN)
      IF(ISALT-1)15,15,14
15    READ(5,2)(TESALT(ING,I),ING=1,INGRAN)
14    CONTINUE
6     READ(5,16)(FLOW(I),I=1,NGAGES)
16    FORMAT(12F6.0)
      RETURN
      END
      SUBROUTINE DATFEW(WA,NSEAS,CAP,S,DEAD,DEFTMP,DEFC,DEFB,NSERVE,
     1KSERVE,ITRAN,TRADIR,ITPPIP,AVWQ,SDWQ,AVCONC,SDCONC,AVNEED,SDNEED,
     2CRIT,ACONT,REGCO,SESALT,TESALT)
      DIMENSION WA(18,5),CAP(15),S(15),DEAD(15),DEFB(15,12),DEFC(15,12),
     1DEFTMP(15,12),ITRAN(15),NSERVE(25),KSERVE(25,10),TRADIR(15,12),
     2ITPPIP(15),AVWQ(10,1,12),SDWQ(10,1,12),AVCONC(10,5,12),SDCONC(10,5
     3,12),AVNEED(25,12),SDNEED(25,12),CRIT(25,5,12),ACONT(5,50),REGCO(5
     4,50),SESALT(5,50),TESALT(5,50),NCHAN(20)
C
C
C     ARGUMENT DEFINITIONS
C
C     WA-DESCRIPTION CARDS FOR PARAMETER UPDATE USING OPTION- NFEW=1
C
C     NSEAS- NUMBER OF SEASONS ( TIME FRAMES PER YEAR)
C
C     CAP- CAPACITY OF EACH RESERVOIR (UNITS MUST BE INPUT COMPATIBLE
C     WITH STREAMFLOW,WASTE FLOW ,TARGETS,ETC.)
C
C     S- STARTING STORAGE IN EACH RESERVOIR- RECKONED FROM ZERO)
C
C     DEAD- MINIMUM POOL STORAGE IN EACH RESERVOIR.
C     E.G. VOLUME OF STORAGE BELOW OUTLET (PIPE, RECREATIONAL POOL VOL.
C
C     GENERAL FORM OF INPUT RESERVOIR RULE CURVES.
C     DRAFT(IS)=A(IS) + B(IS)*INFLOW(IS) + C(IS)* STORAGE(IS-1)
C
C     DEFTMP = A. WHEN B(IS) AND C(IS) ARE ZERO AND A(IS) IS LESS THAN
C     ZERO, THEN A(IS) IMPLIES A FRACTIONAL CAPACITY VOLUME RULE.
      CONTINUE
C
C     DEFB = B
C
C     DEFC= C
C
C     NSERVE- NUMBER OF DAMS TO MAKE AUGMENTATIONS FOR WATER USERS AT
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C     TEST AND JUNCTION POINTS.  THESE ARE UPSTREAM FIRST TIER DAMS.
C
C     KSERVE-LOCATIONS OF THE RESERVOIRS SERVING TEST AND JUNCTION POINT
C
C     ITRAN-LOCATION OF THE TEST POINT TO WHICH DAM(I) IS TO DELIVER
C     WATER.  THIS IS THE EXPLICIT DIVERSION OPTION.  DIMENSION OF ITRAN
C     IS 15.
C     ITRAN(I)=JTH COORD. TO WHICH DAM(I) IS TO DELIVER WATER.  INDEX
C     I IS THE ORDER IN WHICH THE DAMSITES APPEAR IN THE ROUTING.
C
C     TRADIR- SEASONAL EXPLICIT DIVERSION QUANTITY FOR THE ITH DAM.
C     SAME NOTE APPLICABLE TO INDEX I.
C
C     ITPPIP- COORD. OF TEST POINT THAT THE ITH DAM IS TO MAKE A
C     CONDITIONAL DIVERSION FOR WATER QUALITY OR FLOW REQUIREMENT
C     DEFICIENCY.
C
C     AVWO- MEAN WASTE VOLUME OF ALL POLLUTANTS AT SITE(IWASTE),SEASON(I
C
C     SDWO- STD. DEV. WASTE VOLUME AT WASTE SITE(IWASTE),SEASON(IS)
C
C     AVCONC- MEAN POLLUTANT WEIGHT,SITE(IWASTE),POLLUTANT(NW),SEASON(IS
C
C     SDCONC-STD. DEV. POLLUT. WT., SITE(IWASTE),POLLUT.(NW),SEASON(IS)
      CONTINUE
C
C     AVREQD- MEAN FLOW REQUIREMENT AT TEST SITE(IJUNK),SEASON(IS)
C     SDREQD-STD. DEV. OF FLOW REQUIREMENT AT TEST SITE(IJUNK),SEASON(IS
C
C     CRIT-WATER QUAL. STANDARD FOR TEST SITE(IJUNK),POLLUTANT(NW),
C     SEASON(IS)- STD. ORDER MUST BE SAME AS POLLUTANT ORDER.
C
C     ACONT- CONSTANT IN THE OPTIONAL EQUATIONS NOTED IN (REGCO.
C
C     REGCO- UNDER OPTION ISALT=1- SLOPE OF EXPON. EQ.  RELATING CONCEN.
C     OF THE ITH CONSERVATIVE POLLUTANT TO LOCAL INFLOW FOR EACH COORD.
C     REGCO- UNDER OPTION ISALT=2- SLOPE OF LINEAR EQ.  RELATING CONCEN.
C     OF THE ITH COORD. TO A SPECIFIED QUALITY MONITORING STATION(ISALMP
C
C     SFSALT- UNDER OPTION ISALT=1- UPPER LIMIT OF CONCENTRATION FOR THE
C     ITH CONSERVATIVE POLL. AT THE JTH COORD.
C     SFSALT- UNDER OPTION ISALT=2- STD. ERR. OF ESTIMATE OF REGRESSION
C     EQ. RELATING CONCENTRATION AT ITH COORD. TO KTH MONITORING STATION
C     A RANDOM COMPONENT PROPOR. TO STD. ERR. EST. WILL BE ADDED TO
C     THE REGRESSED QUALITY.
C
C     TFSALT-FOR OPTION ISALT=1- LOWER LIMIT OF CONCENTRATION FOR THE
C     ITH CONSERVATIVE POLLUT. AT THE JTH COORD.
C     TFSALT- ISALT=2 -- NOT USED.
C
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      CONTINUE
C     THERE ARE 20 PARAMETERS THAT CAN BE CHANGED.
C     CAUTION- THE CHANGES MADE IN THE (I-1)TH RUN WILL REMAIN IN
C     MEMORY IF NOT UPDATED DURING THE ITH RUN.
C     NOTE THAT THIS SUBROUTINE CAN BE USED TO DYNAMICALLY UPDATE DATA
C     DURING A SIMULATION RUN BY A FEW MINOR PROGRAM CHANGES.
C     ALSO NOTE THAT FOR SEVERAL OF THE PARAMETERS, A COMPLETE SEASONAL
C     CHANGE IS COUNTED AS ONE CHANGE IF ONE IS ADDED TO THE NUMBER OF
C     SEASONS INPUTTED.
C     CAUTION- STARTING STORAGE IN RESERVOIRS(S) MUST BE UPDATED IN
C     EACH RUN.- (S) IS USED AS A WORKING VECTOR.
C
C     NCHAN- EACH ENTRY DENOTES N CHANGES FOR THE JTH DESIGN PARAMETER.
      DO 1 I=1,5
    1 READ(5,2)(WA(J,I),J=1,18)
    2 FORMAT(18A4)
      READ(5,3)(NCHAN(I),I=1,20)
    3 FORMAT(10I5)
    4 FORMAT(I5,F10.0)
    5 FORMAT(2I5,F10.0)
    6 FORMAT(3I5,F10.0)
    7 FORMAT(6F10.0)
      NSEAS=NSEAS+1
      II=1
   13 DO 8 I=II,20
      KK=NCHAN(I)
      IF(KK)8,8,10
   10 KJ=I
      GO TO 11
    8 CONTINUE
      GO TO 12
   11 FKJ=KJ
      IF(FKJ/10.0-1.0)14,14,15
   14 GO TO (16,17,18,19,20,21,22,23,24,25),KJ
   15 KJ=KJ-10
      GO TO (26,27,28,29,30,31,32,33,34,35),KJ
   16 DO 36 L=1,KK
      READ(5,4)N,X
   36 CAP(N)=X
      GO TO 100
   17 DO 37 L=1,KK
      READ(5,4)N,X
   37 DEAD(N)=X
      GO TO 100
   18 DO 38 L=1,KK
      READ(5,4)N,X
   38 S(N)=X
      GO TO 100
   19 DO 39 L=1,KK
      READ(5,5)I,J,X
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```
      IF(J-MSEAS)40,41,41
41    LL=J-1
      READ(5,7)(DEFTMP(I,LK),LK=1,LL)
      GO TO 39
40    DEFTMP(I,J)=X
39    CONTINUE
      GO TO 100
20    DO 42 I=1,KK
      READ(5,5)I,J,X
      IF(J-MSEAS)43,44,44
44    LL=J-1
      READ(5,7)(DEFB(I,LK),LK=1,LL)
      GO TO 42
43    DEFB(I,J)=X
42    CONTINUE
      GO TO 100
21    DO 45 I=1,KK
      READ(5,5)I,J,X
      IF(J-MSEAS)46,47,47
47    LL=J-1
      READ(5,7)(DEFC(I,LK),LK=1,LL)
      GO TO 45
46    DEFC(I,J)=X
45    CONTINUE
      GO TO 100
22    DO 48 L=1,KK
      READ(5,3)M,NN
      NSERVE(M)=NN
48    READ (5,3)(KSERVE(N,LK),LK=1,NN)
      GO TO 100
23    DO 49 L=1,KK
      READ(5,6)I,J,K,X
      ITRAN(I)=J
      IF(K-MSEAS)50,51,51
51    LL=K-1
      READ(5,7)(TRA DIK(I,LK),LK=1,LL)
      GO TO 49
50    TRA DIK(I,K)=X
49    CONTINUE
      GO TO 100
24    DO 52 L=1,KK
      READ(5,3)I,J
52    ITEMP(I)=J
      GO TO 100
25    DO 53 L=1,KK
C
      READ(5,5)I,K,X
      IF(K-MSEAS)54,55,55
55    LL=K-1
      READ(5,7)(AVWO(I,1,LK),LK=1,LL)
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```
      GO TO 53
   54 AVWO(I,1,K)=X
   53 CONTINUE
      GO TO 100
   26 DO 56 L=1,KK
      READ(5,5)I,K,X
      IF(K-MSEAS)57,58,58
   58 LL=K-1
      READ(5,7)(SDWO(I,1,LK),LK=1,LL)
      GO TO 56
   57 SDWO(I,1,K)=X
   56 CONTINUE
      GO TO 100
   27 DO 59 L=1,KK
      READ(5,6)I,J,K,X
      IF(K-MSEAS)60,61,61
   61 LL=K-1
      READ(5,7)(AVCONC(I,J,LK),LK=1,LL)
      GO TO 59
   60 AVCONC(I,J,K)=X
   59 CONTINUE
      GO TO 100
   28 DO 62 L=1,KK
      READ(5,6)I,J,K,X
      IF(K-MSEAS)63,64,64
   64 LL=K-1
      READ(5,7)(SDCONC(I,J,LK),LK=1,LL)
      GO TO 62
   63 SDCONC(I,J,K)=X
   62 CONTINUE
      GO TO 100
   29 DO 65 L=1,KK
      READ(5,5)I,J,X
      IF(J-MSEAS)66,67,67
   67 LL=J-1
      READ(5,7)(AVNEED(I,LK),LK=1,LL)
      GO TO 65
   66 AVNEED(I,J)=X
   65 CONTINUE
      GO TO 100
   30 DO 68 L=1,KK
      READ(5,5)I,J,X
      IF(J-MSEAS)69,70,70
   70 LL=J-1
      READ(5,7)(SDNEED(I,LK),LK=1,LL)
      GO TO 68
   69 SDNEED(I,J)=X
   68 CONTINUE
      GO TO 100
   31 DO 71 L=1,KK
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```
      READ(5,6)I,J,K,X
      IF(K-NSEAS)72,73,73
73    LL=K-1
      READ(5,7)(CRIT(I,J,LK),LK=1,LL)
      GO TO 71
72    CRIT(I,J,K)=X
71    CONTINUE
      GO TO 100
32    DO 74 L=1,KK
      READ(5,5)I,J,X
74    ACONC(J,I)=X
      GO TO 100
33    DO 75 L=1,KK
      READ(5,5)I,J,X
75    ...(J,I)=X
      GO TO 100
34    DO 76 L=1,KK
      READ(5,5)I,J,X
76    SESALT(J,I)=X
      GO TO 100
35    DO 77 L=1,KK
      READ(5,5)I,J,X
77    TESALT(J,I)=X
100   II=K+1
      IF(II-20)13,13,12
12    RETURN
      END
C
      SUBROUTINE SET(NDAMS,NFILL,NDRY,NSEAS,NWVBLS,NPOINT,AMBENT,OULMAX,
     1OULMIN,NOEFV,NOX,NOX3,OEFFCH,NGAGES,NSKIP,NBINRY,NTAPE,FLOW,NTYPE,
     2LOJUNK,LOJUNK,DAMCON,DAMSS,DAMMAX,DAMMIN)
      DIMENSION NFILL(15),NDRY(15),AMBENT(50,5),OULMAX(25,5),OULMIN(25,5
     1),NOEFV(25,12),NOX(25,6,12),NOX3(25,6),OEFFCH(25,6,12),
     2FLOW(50),NTYPE(50),LOJUNK(15),LOJUNK(25),DAMCON(50,5),DAMSS(15,5),
     2DAMMAX(15,5),DAMMIN(15,5)
C
C     ARGUMENT DEFINITIONS
C
C     NDAMS- NUMBER OF DAMS IN SYSTEM
C     NFILL-COUNTS NUMBER OF TIMES RESERVOIRS SPILLED.- TIME INVARIANT.
C
C     NDRY- COUNTS NUMBER OF TIMES RESERVOIRS EMPTIES TO DEAD STORAGE.
C
C     NSEAS- NUMBER OF SEASONS ( TIME FRAMES PER YEAR)
C
C     NWVBLS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
C
C     NPOINT- NUMBER OF COORD. IN SYSTEM
C
C     AMBENT- SYSTEM CONCENTRATION OF JTH POLLUT. AT ITH COORD.
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B 30

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C
C     OULMAX- MAXIMUM CONCENTRATION OF ITH POLLUT. AT JTH TEST SITE.
C
C     OULMIN- MINIMUM CONCENTRATION OF JTH POLLUT. AT ITH TEST SITE.
C
      CONTINUE
C     NOFFY- COUNTER OF SEASONAL FAILURES TO MEET A FLOW TARGET OR WATER
C     QUALITY STANDARD AT ALL TEST POINTS AND JUNCTION POINTS.
C     N. .- 6 POSSIBLE TARGETS CAN BE USED AT A TESTPOINT.IF DURING THE
C     ITH FRAME AND AT THE JTH TESTPOINT, ALL 6 TARGETS ARE VIOLATED,
C     NOFFY IS INCREMENTED BY ONE.
C
C     GENERAL NOTES.
C     FAILURE IMPLIES THAT A FLOW TARGET WAS NOT MAINTAINED OR IN THE
C     CASE WHERE THE FLOOD MONITORING OPTION IS SPECIFIED, THE FLOW
C     EXCEEDS THE TARGET. WATER QUALITY TARGETS ARE VIOLATED WHEN THE
C     CONCENTRATION OF THE JTH POLLUT. EXCEEDS THE VALUE OF JTH STANDARD
C     MAGNITUDE OF A FAILURE IS AMT. OF WATER NECESSARY TO MAINTAIN A
C     FLOW TARGET OR BRING THE CONCENTRATION DOWN TO SATISFY A W.Q.S.
C     IN THE LATTER SITUATION, THIS QUANTITY HAS ZERO CONCENTRATION.
C     THIS NUMBER IS MEANINGFUL ONLY WHEN THE CONCENTRATION OF THE WATER
C     IN A RESERVOIR THAT COULD SUPPLY THIS QUANTITY IS CONSIDERED.
C
C     FOX3-COUNTER OF TIMES WHICH POLLUT. OR FLOW TARGET CAUSED
C     MAXIMUM DEFICIENCY OR FAILURE DURING ITH TIMEFRAME.
C
      CONTINUE
C     NOX - COUNTER OF NUMBER OF TIMES JTH TARGET WAS VIOLATED DURING
C     THE ITH SEASON AT THE KTH TEST SITE.
C
C     DEFECH- MAX. FAILURE FOR JTH TARGET DURING ITH SEASON FOR KTH.SITE
C
C     NSKIP- NUMBER OF YEARS FLOW TAPE IS TO BE SKIPPED FORWARD.
C
C     NBINRY-KEY DENOTING WHETHER FLOW TAPE DATA IS IN BINARY OR IN BCD.
C
C     NTAPE- LOGICAL TAPE NUMBER OF FLOW TAPE.
C
C     FLOW- HYDROLOGIC FLOWS AT GAGING STATIONS. ALSO UNDER ISALT=2 OPTI
C     FLOW WILL ALSO CONTAIN SIMULATED WATER QUALITY AT MONITORING STA.
C     INPUT ENTRY IS ORDER IN WHICH THE PROGRAM ENCOUNTERS TEST POINTS.
C     THESE ARE INPUT EXOGENOUS DATA TO THE ROUTING.
C
C     NTYPE- NUMERIC DESCRIPTION OF EACH COORD.
C
C     LODAM-MAP RELATING DAM INPUT ORDER TO DAM COORD NUMBER.  THE
C     (IDAM)TH ENTRY IS ITS COORD. NUMBER.
C
C     LOJUNK- MAP RELATING TESTPOINTS TO COORD. NUMBER. THE (IJUNK)TH
C     IS ITS COORD. NUMBER.
```

```
C
C     DAMCON- CONCENTRATION OF JTH WASTE IN ITH DAM. CONCENTRATIONS AT
C     END OF ITH FRAME ARE BEGINING CONCENTRATIONS OF (I+1)TH FRAME.
C
C     DAMSS- INTIAL CONCENTRATIONS OF RESERVOIRS WITH NONZERO STARTING
C     STORAGE. THESE CONCENTRATIONS ARE USED FOR EACH RUN.
C
C     DAMMAX- MAX. CONCENTRATION OF JTH POLLUT  FOR ITH DAM. TIME-INVAR.
C
C     DAMMIN- MIN. CONCENTRATION OF JTH POLLUT  FOR ITH DAM. TIME-INVAR.
C
C
C     INITIALIZE MATRICES.
C
      IF(NDAMS)1,1,2
2     DO 3 I=1,NDAMS
      NFILL(I)=0
3     NORY(I)=0
1     IF(NWVBLS)4,4,5
5     DO 6 J=1,NWVBLS
      DO 6 I=1,NPOINT
6     AMBENT(I,J)=0.0
      DO 7 I=1,25
      DO 7 J=1,NWVBLS
      OULMAX(I,J)=0.0
7     OULMIN(I,J)=99999.
4     DO 8 I=1,25
      DO 8 K=1,12
8     NDEFY(I,K)=0
      DO 9 I=1,25
      DO 9 J=1,6
      NOX3(I,J)=0
      DO 9 K=1,12
      NOX(I,J,K)=0
9     DEFFCH(I,J,K)=0.0
C
C     DETERMINING IF INPUT FLOWS ARE IN BCD(SYSTEM TAPE) OR IN BINARY.
C
      IF(NTAPE-5)40,41,40
41    NBINRY=0
      GO TO 42
40    NBINRY=1
C
C     POSITION FLOW TAPE
C
42    IF(NBINRY)30,30,31
31    REWIND NTAPE
30    CONTINUE
      IF(NSKIP-1)11,11,12
12    NSKIP= NSKIP-1
```

```
      NSKIP=NSKIP*NSEAS
      DO 14 I=1,NSKIP
      IF(NBINRY)15,15,16
16    READ (NTAPE)(FLOW(J),J=1,NGAGES)
      GO TO 14
15    READ(5,160)(FLOW(J),J=1,NGAGES)
160   FORMAT(12F6.0)
14    CONTINUE
11    CONTINUE
C
C     MAP OF TEST AND JUNCTION POINTS VS COORDINATE
C     MAP OF DAMS VS COORDINATE
C
      IJU=0
      IDAM=0
      DO 18 K=1,NPOINT
      KK=NTYPE(K)
      GO TO (19,18,21,19,18),KK
21    IDAM=IDAM+1
      LODAM(IDAM)=K
      GO TO 18
19    IJU=IJU+1
      LOJUNK(IJU)=K
18    CONTINUE
      IF(NWVBLS)22,22,23
23    DO 24 IDAM=1,NDAMS
      LOOM=LODAM(IDAM)
      DO 24 NW=1,NWVBLS
C
C     INITIALIZE MATRICES.
C     TRANSFERRING DAM CONCENTRATIONS FROM ORDER IN WHICH THEY WERE READ
C     IN TO THE ACTUAL LOCATION
C
      DAMMIN(IDAM,NW)=99999.
      DAMMAX(IDAM,NW)=0.0
24    DAMCON(LOOM,NW)=DAMSS(IDAM,NW)
22    RETURN
      END
C
      SUBROUTINE SET1(NWRIT,NSEAS,NITER,IPIPE,NSER,NSERVE,ISALT,ISALMP,
     1XGAGE,NPOINT,OQX,DEFX,YRMAX,YRCOU,NDO,INVEST)
      DIMENSION NWRIT(12),NSERVE(25),ISALMP(50),KGAGE(50),OOX(50,12)
      DIMENSION DEFX(25),YRMAX(25),YRCOU(25),NDO(20)
C
C     ARGUMENT DEFINITIONS
C
C     NWRIT- USED IN HEADING OUTPUT.
C
C     NSEAS-NUMBER OF SEASONS
C
```

```
C     NITER- NUMBER OF TIMES THE PROGRAM IS TO ITERATE TO SATISFY NEEDS.
C
C     IPIPE- CONDITIONAL DIVERSION KEY
C
C     NSER- NUMBER OF TEST AND JUNCTION POINTS IN SYSTEM
C
C     NSERVE- NUMBER OF DAMS TO MAKE AUGMENTATIONS FOR WATER USERS AT
C     TEST AND JUNCTION POINTS.  THESE ARE UPSTREAM FIRST TIER DAMS.
C
C     ISALT- KEY FOR COMPUTING CONSERVATIVE BACKGROUND CONCEN.-
C
C     ISALMP- UNDER OPTION ISALT=2- MAP RELATING ITH COORD. TO THE JTH
C     WATER QUALITY MONITORING STATION. THESE SIMULATED VALUES WILL BE
C     INPUTTED IN (FLOW)- NO ENTRY IN KGAGE AND ISALMP ARE THE SAME.
C
C     KGAGE- COORD. - FLOW GAGING STATION REFERENCING MAP.
C
C     NPOINT- NUMBER OF CO-ORD. IN SYSTEM.
C
C     QQX- MAX. SYSTEM FLOW FOR ITH COORD. FOR JTH SEASON.
C
C     YRMAX- MAXIMUM YEARLY FAILURE AT EACH SITE
C
C     QFFX- MAXIMAL SEASONAL FAILURES AT EACH SITE
C
C
C     YRCOU- COUNT OF YEARLY FAILURES AT EACH TEST SITE.
C
C     NOO- PRINTING SUPPRESS
C
C     IGVES- LINK TO WHICH PROGRAM WILL PROCEED WHEN FINISHED ROUTING
C     ALL PLANS. IF ALL FLAGS ARE DEPRESSED IN ISKIP, THEN THIS LINK
C     WRITES SEASONAL AND YEARLY PROBABILITIES OF FAILURE FOR EACH PLAN
C     (MULTI-RUN) AND THEN RETURNS TO EXECUTIVE ROUTINE.
C
      DO 1 I=1,NSER
      YRMAX(I)=0.0
      YSCOU(I)=0.0
    1 QFFX(I)=0.0
      DO 2 I=1,NPOINT
      DO 2 J=1,NSEAS
    2 QQX(I,J)=-10.0**10
      DO 3 I=1,NSEAS
    3 NNRIT(I)=1
C
C     DETERMINING MAXIMUM NUMBER OF ITERATIVE ROUTING ATTEMPTS.
C
      NITER=1
      IF(IPIPE)4,4,5
C
```

```
C     UP TO TWO PASSES ALLOWED FOR CONDITIONAL DIVERSIONS.
C
5     NITER=3
4     DO 6 I=1,NSFR
      IF(NSERVE(I))6,6,7
C
C     UP TO THREE PASSES ALLOWED FOR DOWNSTREAM FLOW REQDS.
C
7     NITER=NITER+3
      GO TO 8
6     CONTINUE
C
C     CHECKING FLOW AND QUALITY REFERENCING CONSISTENCY.
C
8     IF(ISALT-1)9,9,10
10    DO 11 I=1,NPOINT
      IF(KGAGE(I)-ISALMP(I))11,12,11
11    CONTINUE
      GO TO 9
12    CALL EXIT
9     DO 13 I=1,19
      IF(I-16)14,14,15
14    IF(DDUM(I))16,16,13
16    IDVES=6
      GO TO 18
15    IF(DDUM(I))17,17,13
17    IDVES=7
      GO TO 18
13    CONTINUE
      IDVES=5
18    RETURN
      END
      SUBROUTINE FCHOI(NPOINT,KGAGE,FACTOR,CR,NDAMS,CAP,S,DEAD,DEFTMP,
     1DEFN,DEFC,NSFAS,NSER,NSERVE,KSERVE,ITRDIV,LODAM,ITRAN,LOJUNK,
     2ICADIR,IPIPE,ITPPIP,IOPT)
      DIMENSION KGAGE(50),FACTOR(50),CR(50),CAP(15),S(15),DEAD(15),
     1DEFTMP(15,12),DEFN(15,12),DEFC(15,12),NSERVE(25),KSERVE(25,10),
     2LODAM(15),ITRAN(15),LOJUNK(25),TRADIR(15,12),ITPPIP(15)
C
C     ARGUMENT DEFINITIONS
C
C     NPOINT- NUMBER OF COORD. IN SYSTEM
C
C     KGAGE- COORD.-FLOW GAGING STATION REFERENCING MAP.
C
C     FACTOR- SCALES FLOWS AT GAGING STATIONS TO INFLOWS INTO EACH COORD
C
C     CR- GILCHRIST ROUTING COEFF.- SET EQUAL TO 1
C
C     NDAMS- NUMBER OF DAMS IN SYSTEM
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C
C     CAP- CAPACITY OF EACH RESERVOIR (UNITS MUST BE INPUT COMPATIBLE
C
C     E.G. VOLUME OF STORAGE BELOW OUTLET IPIPE, RECREATIONAL POOL VOL.
C     S- STARTING STORAGE IN EACH RESERVOIR- RECKONED FROM ZERO)
C     DEAD- MINIMUM POOL STORAGE IN EACH RESERVOIR.
C
C     GENERAL FORM OF INPUT RESERVOIR RULE CURVES.
C     DRAFT(IS)=A(IS) + B(IS)*INFLOW(IS) + C(IS)* STORAGE(IS-1)
C     DEFIAP = A. WHEN B(IS) AND C(IS) ARE ZERO AND A(IS) IS LESS THAN
C     ZERO, THEN A(IS) IMPLIES A FRACTIONAL CAPACITY VOLUME RULE.
C
      CONTINUE
C     DEFB = B
C     DEFC= C
C
C     IEXDIV- EXPLICIT DIVERSION KEY
C
C     IDMAP-MAP RELATING DAM INPUT ORDER TO DAM COORD NUMBER.  THE
C     IDMAP ITH ENTRY IS ITS COORD. NUMBER.
C
C     ITRAN-LOCATION OF THE TEST POINT TO WHICH DAM(I) IS TO DELIVER
C     WATER.  THIS IS THE EXPLICIT DIVERSION OPTION.  DIMENSION OF ITRAN
C     IS 15.
C
C     ITRAN(I)=JTH COORD. TO WHICH DAM(I) IS TO DELIVER WATER.  INDEX
C     I IS THE ORDER IN WHICH THE DAMSITES APPEAR IN THE ROUTING.
C
C     IJUNK- MAP RELATING TESTPOINTS TO COORD. NUMBER. THE (IJUNK)TH
C     IS ITS COORD. NUMBER.
C     NSTP- NUMBER OF TEST AND JUNCTION POINTS IN SYSTEM
C
C     TRADIR- SEASONAL EXPLICIT DIVERSION QUANTITY FOR THE ITH DAM.
C
C     IPIPE- CONDITIONAL DIVERSION KEY
C
C     ITPPIP- COORD. OF TEST POINT THAT THE ITH DAM IS TO MAKE A
C     CONDITIONAL DIVERSION FOR WATER QUALITY OR FLOW REQUIREMENT
C     DEFICIENCY.
C     SAME NOTE APPLICABLE TO INDEX I.
C
      WRITE (6,1)
    1 FORMAT (1H1/1H09HDATA ECHO///1H049HCORD. GAGE REFERENCE DRAINAGE R
     1ATIO ROUTING COEF.///)
      DO 2 I=1,NPOINT
    2 WRITE (6,3)I,KGAGE(I),FACTOR(I),CR(I)
    3 FORMAT (1H I4,I5,10X,F9.4,5X,F8.3)
      IF(NDAMS)4,4,5
    5 WRITE(6,6)
    6 FORMAT (1H0/1H03HDAM,7X,4HCAP.,6X,9HINI. STOR,4X,4HDEAD///)
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```
      DO 7 I=1,NDAMS
    7 WRITE(6,8)I,CAP(I),S(I),DEAD(I)
    8 FORMAT (1H 12,2X,3E14.4)
      WRITE(6,9)
    9 FORMAT (1H051HSEASONAL OPERATING RELEASE RULES FOR EACH RESERVOIR/
     1/1H03HDAM///)
      DO 10 I=1,NDAMS
   10 WRITE(6,11)I,(DEFTMP(I,K),K=1,NSEAS),(DEFH(I,K),K=1,NSEAS),
     1(DEFC(I,K),K=1,NSEAS)
   11 FORMAT(1H I4,12F10.3/1H 4X,12F10.3/1H 4X,12F10.3)
   12 FORMAT (1H1/1H042HT.P.  NUMBER DAMS SERVICING **** LOCATIONS,20X,
     117HALLOCATION OPTION,I5)
      WRITE(6,12)IOPT
      DO 13 I=1,NSER
      NS=NSERVE(I)
      IF(NS)13,13,130
  130 WRITE(6,14)I,NSERVE(I),(KSERVE(I,K),K=1,NS)
   13 CONTINUE
   14 FORMAT (1H I4,I13,13X,10I5)
      IF(ITRDIV)15,15,16
   16 WRITE(6,17)
   17 FORMAT(1H1/1H021HTRANSBASIN DIVERSIONS///1H03HDAM,2X,2HCO,3X,
     116HDELIVER WATER TO,2X,7HTEST PT,3X,2HCO//)
      DO 18 I=1,NDAMS
      LOD=LODAR(I)
      ITR=ITRAN(I)
      DO 19 J=1,NSER
      KJ=J
      KK=LOJORK(J)
      IF(ITR-KK)19,20,19
   20 WRITE(6,21)I,LOD,KJ,ITR
      GO TO 18
   19 CONTINUE
   18 CONTINUE
   21 FORMAT(1H0I3,I4,21X,I5,5X,I2)
      WRITE(6,22)
   22 FORMAT(1H1/1H03HDAM,2X,2HCO,2X,19HSEASONAL DIVERSIONS//)
      DO 23 I=1,NDAMS
      LOD=LODAR(I)
   23 WRITE(6,24)I,LOD,(TRA DIR(I,K),K=1,NSEAS)
   24 FORMAT(1H I3,I4,2X,12F10.3)
   15 IF(IPIPE)4,4,25
   25 WRITE(6,26)
   26 FORMAT (1H086HTEST POINTS THAT RECEIVE CONDITIONAL DIVERSIONS FROM
     1 A DAM AT THE FOLLOWING LOCATION///1H04HT.P.,5X,2HCO,5X,
     23HDAM,5X,2HCO//)
      DO 27 I=1,NDAMS
      LOD=LODAR(I)
      LJ=IPPIP(I)
      DO 28 J=1,NSER
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      KJ=LOJUNK(J)
      IF(KJ-LJ)28,29,28
   28 CONTINUE
      GO TO 27
   29 WRITE(6,30) J,LJ,I,LOD
   27 CONTINUE
   30 FORMAT(1H0,I4,5X,I2,5X,I3,5X,I2)
    4 RETURN
      END
      SUBROUTINE FCHK2(IEVAP,IDAMEV,NDAMS,IRFEV,FACEVP,ACOEVP,XCOEVP,
     1IRFVEC,EVPXM,EVPSD,NSEAS,NWVBLS,FLOMIN,FLCMIN,NWASTE,AVWQ,SDWQ,
     2AVCONC,SDCONC,DAMSS)
      DIMENSION IDAMEV(15),IRFEV(15),FACEVP(15),ACOEVP(15),XCOEVP(15),
     1EVPXM(3,12),EVPSD(3,12),FLOMIN(10),FLCMIN(10,5),AVWQ(10,1,12),
     2SDWQ(10,1,12),AVCONC(10,5,12),SDCONC(10,5,12),DAMSS(15,5)
C
C      ARGUMENT DEFINITIONS
C
C      IEVAP- EVAPORATION OF RESERVOIR STORAGE KEY
C
C      IDAMEV- RESERVOIR BY INPUT ORDER WHOSE STORAGE IS TO BE EITHER
C      DEPLETED OR AUGMENTED BY EVAPORATION(+OR-) IN THE ROUTING)
C
C      IRFEV- MAP RELATING EACH DAM(INPUT ORDER) TO REGIONAL EVAPORATION
C      VECTOR.
C
C      FACEVP-FACTOR TO SCALE THE REGIONAL EVAPORATION RATE TO THAT AT
C      THE DAMSITE. NOTE ENTRY IS DAM INPUT ORDER.
C
C      ACOEVP- CONSTANT IN LINEAR EQU. RELATING AREA TO VOLUME FOR
C      EACH DAMSITE. OTHER FUNCTIONS CAN BE USED IF NEED BE.
C
C      XCOEVP- SLOPE FOR LINEAR EQU. RELATING AREA TO VOLUME. (EACH DAM)
C
C      IRFVEC- NUMBER (EQUAL OR LESS -3) OF REGIONAL SEASONAL EVAPORATION
C      VECTORS.  UNITS MUST BE MADE CONSISTENT-A PRIORI.
C
C      EVPXM-SEASONAL(IS) MEAN EVAPORATION RATE , ITH VECTOR
C
C      EVPSD- SEASONAL(IS) STD. DEVNS. OF EVAPORATION RATE, ITH VECTOR
C
C      NWVBLS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
C
C      DAMSS- CONCENTRATION (NN) FOR DAMS WITH STARTING STORAGE -NONZERO.
C      ENTRY IS BY DAM ORDER WITH NONZERO STORAGE. SAME FOR EACH RUN.
C
C      NWASTE- NUMBER OF WASTE SITES IN SYSTEM
C
C      FLOMIN- MINIMUM WASTE FLOW AT WASTE SITE J- TIME INVARIANT
C
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C     FLCMIN- MINIMUM WASTE WEIGHT- SITE I POLLUTANT J-  TIME-INVARIANT
C
C     AVWO- MEAN WASTE VOLUME OF ALL POLLUTANTS AT SITE(IWASTE),SEASON(I
C
C     SDWO- STD. DEV. WASTE VOLUME AT WASTE SITE(IWASTE),SEASON(IS)
C
C     AVCONC- MEAN POLLUTANT WEIGHT,SITE(IWASTE),POLLUTANT(NW),SEASON(IS
C
C     SDCONC-STD. DEV. POLLUT. WT., SITE(IWASTE),POLLUT.(NW),SEASON(IS)
C
      WRITE(6,1)IEVAP
    1 FORMAT (1H07HEVAPOR.,I4)
      IF(IEVAP)2,2,3
    3 WRITE (6, 4)(IDAMEV(I),I=1,NDAMS),(IREFEV(I),I=1,NDAMS),(FACEVP(I),
     1I=1,NDAMS),(ACOEVP(I),I=1,NDAMS),(XCOEVP(I),I=1,NDAMS)
    4 FORMAT (1H016HDAMS EVAPORATING/1H 5X,15I6/1H029HDAM REFERENCE TO E
     1VAP. VECTOR/1H 5X,15I6/1H035HFACTOR RELATING DAM TO EVAP. VECTOR/
     11H 5X,15F6.2/1H037HCONST. IN AREA-VOL. EQU. FOR EACH DAM/1H 5X,15
     1F6.2/1H022HREGR. COEF FOR A-V DAM/1H 5X,15F6.2)
      WRITE(6,5)
    5 FORMAT (1H037HEVAP. VECTOR SEASONAL MEANS,THEN S.D./)
      DO 6 I=1,IEPVEC
    6 WRITE (6, 7)I,(EVPXM(I,K),K=1,NSEAS),(EVPSD(I,K),K=1,NSEAS)
    7 FORMAT (1H I5,12F9.3/1H 5X,12F9.3)
    2 IF(NWVBLS)8,8,9
    9 IF(NDAMS)10,10,11
   11 WRITE(6,12)
   12 FORMAT (1H021HINITIAL CONC. IN DAMS/)
      DO 13 I=1,NDAMS
   13 WRITE(6,14) I,(DAMSS(I,K),K=1,NWVBLS)
   14 FORMAT(1H I5,5F15.3)
   10 IF(NWASTE)8,8,15
   15 IF(NWVBLS)8,8,16
   16 WRITE(6,17)
   17 FORMAT (1H1/1H029HSITE MIN. FLOW THEN MIN. WT  )
      DO 18 K=1,NWASTE
   18 WRITE (6,19)K,FLOMIN(K),(FLCMIN(K,NW),NW=1,NWVBLS)
   19 FORMAT (1H0I5,6F15.5)
      WRITE(6,20)
   20 FORMAT (1H010HSITE WASTE,5X,41HSEASONAL MEAN Q, SD Q, MEAN WT. , S
     1D WT. ///)
      DO 21 I=1,NWASTE
      WRITE(6,22)I
   22 FORMAT (1H I4)
      DO 21 J=1,NWVBLS
   21 WRITE (6,23)J,(AVWO(I,1,K),K=1,NSEAS),(SDWO(I,1,K),K=1,NSEAS),(
     1AVCONC(I,J,K),K=1,NSEAS),(SDCONC(I,J,K),K=1,NSEAS)
   23 FORMAT(1H0/1H04X,I4,12F10.1/1H 8X,12F10.1/1H 8X,12F10.1/1H 8X,12
     1F10.1)
    8 RETURN
```

```
      END
C
      SUBROUTINE ECHO3(KEYBOD,NPOINT,BODCON,FMIL,CONSTV,EXPV,OXYWAS,
     1TEMP,NSEAS,OXYDAM,NDAMS,INGRAN,ISALT,ACONT,REGCO,SESALT,TESALT,
     2ISALMP,NSER,AVNEFD,SDNEFD,NNVBLS,CRIT,IFLOD,ITPFLD)
      DIMENSION BODCON(50),FMIL(50),CONSTV(50),EXPV(50),OXYWAS(50),
     1TEMP(12),OXYDAM(15),ACONT(5,50),REGCO(5,50),SESALT(5,50),TESALT(5,
     250),ISALMP(50),AVNEFD(25,12),SDNEFD(25,12),CRIT(25,5,12),ITPFLD(25
     3)
C
C     ARGUMENT DEFINITIONS
C
C     KEYBOD- DEGRADABLE POLLUTANT KEY
C
C     BODCON- BACKGROUND CONCENTRATION OF DEGRADABLE POLLUTANT(KEYBOD=1)
C     FOR LOCAL INFLOWS INTO EACH COORD.- TIME-INVARIANT.
C
C     FMIL - RIVER MILES BETWEEN EACH COORD. JTH ENTRY IS MILES BETWEEN
C     ITH AND (I+1)TH COORDS.
C
C     CONSTV-CONSTANT IN EXPON. EQU. RELATING VELOCITY TO FLOW FOR EACH
C     COORD.--JTH ENTRY FOR ITH AND(I+1)TH COORD.
C
C     EXPV- SLOPE IN EXPON. EQU. RELATING VELOCITY TO FLOW.
C
C     OXYWAS- DECAY COEFF. FOR DEGRAD. POLL. (LOG10-20 DEG.CENT.)
C     FOR ALL COORD.
C     TEMP- MEAN SEASONAL TEMPERATURE (C)- FOR BASIN- SPACE-INVARIANT.
C
C     OXYDAM- DECAY COEFF. FOR DAMSITES. (LOG10-20 DEG. CENT.)
C
C     INGRAN- NUMBER OF CONSERVATIVE POLLUTANTS
C
C     ACONT- CONSTANT IN THE OPTIONAL EQUATIONS NOTED IN IREGCO.
C     CONTINUE
C
C     REGCO- UNDER OPTION ISALT=1- SLOPE OF EXPON. EQ.  RELATING CONCEN.
C     OF THE ITH CONSERVATIVE POLLUTANT TO LOCAL INFLOW FOR EACH COORD.
C     REGCO- UNDER OPTION ISALT=2  SLOPE OF LINEAR EQ.  RELATING CONCEN.
C     OF THE ITH COORD. TO A SPECIFIED QUALITY MONITORING STATION(ISALMP
C
C     SESALT- UNDER OPTION ISALT=1- UPPER LIMIT OF CONCENTRATION FOR THE
C     ITH CONSERVATIVE POLL. AT THE JTH COORD.
C     SESALT- UNDER OPTION ISALT=2- STD. ERR. OF ESTIMATE OF REGRESSION
C     EQ. RELATING CONCENTRATION AT ITH COORD. TO KTH MONITORING STATION
C     A RANDOM COMPONENT PROPOR. TO STD. ERR. EST. WILL BE ADDED TO
C     THE REGRESSED QUALITY.
C
C     TESALT-FOR OPTION ISALT=1- LOWER LIMIT OF CONCENTRATION FOR THE
C     ITH CONSERVATIVE POLLUT. AT THE JTH COORD.
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C     TESALT- ISALT=2 -- NOT USED.
C
C     AVNEED- MEAN FLOW REQUIREMENT AT TEST SITE(IJUNK),SEASON(IS)
C
C     SDNEED-STD. DEV. OF FLOW REQUIREMENT AT TEST SITE(IJUNK),SEASON(IS
C
C     CRIT-WATER QUAL. STANDARD FOR TEST SITE(IJUNK),POLLUTANT(NW),
C     SEASON(IS)- STD. ORDER MUST BE SAME AS POLLUTANT ORDER.
C
C     IFLOW- CHANNEL CAPACITY MONITORING AT TEST POINT KEY
C
C     ITPFLO- FLOWS MONITORING OPTION AT TESTPOINTS. CHECKS FOR EXCESS
C     FLOW RATHER THAN DEFICIENT FLOW . TARGET FLOWS WILL USUALLY BE
C     CHANNEL CAPACITIES. ENTERED IN AVNNEED.
C
C     ISALT- KEY FOR COMPUTING CONSERVATIVE BACKGROUND CONCEN.-
C
C     ISALMP-UNDER OPTION ISALT=2 MAP RELATING ITH COORD. TO THE JTH
C     WATER QUALITY MONITORING STATION. THESE SIMULATED VALUES WILL BE
C     INPUTTED IN (FLOW)- NO ENTRY IN KGAGE AND ISALMP ARE THE SAME.
C
      IF(KEYMOD)1,1,2
    2 WRITE(6,3)
    3 FORMAT (1H1/1H050HCORD. BKGRD, MILE,CONST, EXPON,              DEOX
     1Y,///)
      DO 4 I=1,NPOINT
    4 WRITE (6, 5)I,BODCON(I),FMIL(I),CONSTV(I),EXPV(I),OXYWAS(I)
    5 FORMAT (1H I4,F7.2,F5.0,F6.2,F8.3,F8.3)
      WRITE (6, 6)(TEMR(I),I=1,NSEAS),(OXYDAM(I),I=1,NDAMS)
    6 FORMAT (1H07HTEMPER./1H 12F10.3/1H011HDEOXY. DAMS/1H 15F8.3)
    1 IF(IGGRAV)7,7,8
    8 IF(ISALT-1)9,9,10
    9 WRITE(6,11)
   11 FORMAT (1H0I5HBKGRD SALT DATA/1H 4HCORD,10X,5HWASTE,10X,6HCONST.,
     110X,6HEXPON.,10X,7HMAXIMUM,10X,7HMINIMUM///)
      DO 12 I=1,NPOINT
      WRITE(6,13)I
   13 FORMAT (1H I4)
      DO 12 ING=1,INGRAN
   12 WRITE (6,14)ING,ACONT(ING,I),REGCO(ING,I),SESALT(ING,I),TESALT(ING
     1,I)
   14 FORMAT (1H 14X,I4,10X,F7.2,10X,F6.1,10X,F6.1,10X,F6.1)
      GO TO 7
   10 WRITE(6,15)
   15 FORMAT(1H1/1H043HCOORD. QUALITY MONITORING STATION REFERENCE,2X,
     115HREGRESS. CONST.,2X,14HREGRESS. SLOPE,2X,17HSTD. ERR. OF EST.//)
      DO 16 I=1,NPOINT
   16 WRITE(6,17)I,ISALMP(I),ACONT(1,I),REGCO(1,I),SESALT(1,I)
   17 FORMAT(1H I5,14X,I5,E15.4,2X,E14.4,2X,F17.4)
    7 IF(NSER)18,18,19
```

```
   19 WRITE(6,20)
   20 FORMAT (1H06QHT.P.  SEASONAL MEAN FLOW REQU. THEN SEASONAL STD. FL
     1OW REQU.///)
      DO 21 I=1,MSER
   21 WRITE (6,22)I,(AVNEED(I,J),J=1,NSEAS),(SDNEED(I,J),J=1,NSEAS)
   22 FORMAT (1H I4,12F10.3/1H 4X,12F10.3)
      IF(NQUAL)23,23,24
   24 WRITE(6,25)
   25 FORMAT (1H06HIP   ,5HWASTE,5X,24HSEASONAL QUALITY TARGETS///)
      DO 26 I=1,MSER
      WRITE(6,27)
   27 FORMAT(1H 14)
      DO 26 J=1,NQUALS
   26 WRITE (6,28)J,(CRIT(I,J,K),K=1,NSEAS)
   28 FORMAT (1H 4X,I5,5X,12F9.1)
   23 IF(FLDROUT)1H,1H,29
   29 WRITE(6,30)(TYPFLD(I),I=1,MSER)
   30 FORMAT (1H0/1H06HLIST POINTS CONSIDERED AS FLOOD CONTROL POINTS,
     112I3)
   1H RETURN
      END
      SUBROUTINE UNREG(NBINRY,FLOW,MGAGES,NPOINT,Q,FACTUR,NEXT,UNREG,
     1NTYPE,JUNC,NO,NZ,KGAGE,MTAPE,INTIAL)
      DIMENSION FLOW(50),Q(50),FACTOR(50),NEXT(50),UNREG(50),NTYPE(50)
     1,JUNC(10),A(50),TA(50),KGAGE(50)
C
CUNREG.
C
C     ARGUMENT DEFINITIONS
C
C     NBINRY-KEY DENOTING WHETHER FLOW TAPE DATA IS IN BINARY OR IN BCD.
C
C     FLOW- HYDROLOGIC FLOWS AT GAGING STATIONS. ALSO UNDER ISALT=2 OPTI
C     FLOW WILL ALSO CONTAIN SIMULATED WATER QUALITY AT MONITORING STA.
C
C     MGAGES- NUMBER OF FLOW AND WATER QUALITY MONITORING GAGES.
C
C     NPOINT- NUMBER OF COORD. IN SYSTEM
C
C     Q- TOTAL UPSTREAM INFLOW TO EACH COORD.ONLY APPLICABLE FOR INITIAL
C     TIME FRAME WHEN NON-UNITY ROUTING COEFF. ARE USED.
C     SEE SUBROUTINE ROUTE
C
C     FACTOR- SCALES FLOWS AT GAGING STATIONS TO INFLOWS INTO EACH COORD
C
C     NEXT- IMMED. DOWNSTREAM COORD. OF ITH COORD. PROCEEDING IN NUMERIC
C     ORDER.
C
C     UNREG- LOCAL OR UNREGULATED INFLOWS INTO EACH COORD.   NET INFLOW.
C
```

```
C      NTYPE- NUMERIC DESCRIPTION OF EACH COORD.
C
C      JUNC- COORD. OF EXTREME POINT ON TRIB. TO WHICH ROUTING WILL
C      PROCEED WHEN A JUNCTION POINT IS ENCOUNTERED.
C
C      NO-SCALING FACTOR KEY. SEE MAIN PROGRAM FOR FURTHER NOTES.
C
C      NN- KEY TO FORM TOTAL INFLOW INTO EACH COORD. FOR FLOW
C      INITIALIZATION.
C      ONLY NEEDED WHEN ROUTING COEF. ARE NON-UNITY.
C
C
       IF(INTIAL)35,35,4
35     IF(NBINRY)1,1,2
1      READ(5,3)(FLOW(I),I=1,NGAGES)
       GO TO 4
2      READ(NTAPE)(FLOW(I),I=1,NGAGES)
3      FORMAT(12F6.0)
4      DO 5 I=1,NPOINT
       K=KGAGE(I)
5      Q(I)=FLOW(K)*FACTOR(I)
C
C      IF NO=0, THEN Q(I) CONTAINS INCREMENTAL FLOWS.
C
C***** NO=1
C
C      FINDING INCREMENTAL FLOW
C
       IF(NO)6,6,7
7      DO 8 I=1,NPOINT
       DO 9 J=1,NPOINT
       KJ=J
       IF(NEXT(J)-I)9,10,9
C
C      INFLOWS AT EXTREME POINTS.
C
9      CONTINUE
       UNREG(I)=Q(I)
       GO TO 8
10     IF(NTYPE(I)-4)11,12,11
11     UNRE=Q(I)-Q(KJ)
17     UNREG(I)=AMAX1(UNRE,0.0)
       IF(NTYPE(I)-4)8,13,8
C
C      ASSUMPTION-LOCAL FLOW INTO JUNCTION IS SPLIT EVENLY. NOTE IN THE
C      ROUTING THE JUNCTION IS ENCOUNTERED TWICE. BOTH TIMES LOCAL FLOW
C      IS ADDED.
C
13     UNREG(I)=0.5*UNREG(I)
       GO TO 8
```

```
12    QSAVE=Q(KJ)
      J1=KJ+1
      DO 14 J=J1,NPOINT
      KJ=J
      IF(NEXT(J)-I)14,15,14
14    CONTINUE
      WRITE(6,16)NEXT,I,J1
16    FORMAT (1H0,15HWHAT GIVES HERE?2015)
C
C     QSAVE- FLOW ABOVE JUNCTION AT ONE TRIB.
C     Q(KJ)- FLOW ABOVE JUNCTION AT OTHER TRIB.
C
15    UNREF=Q(I)-QSAVE-Q(KJ)
      GO TO 17
8     CONTINUE
C*****
      GO TO 18
C***** NO=0
6     DO 19 I=1,NPOINT
      IF(NTYPE(I)-4)20,21,20
21    UNREG(I)=0.5*Q(I)
      GO TO 19
20    UNREG(I)=Q(I)
19    CONTINUE
C*****
C
C     RE-CONSTITUTING TOTAL INFLOWS FOR INITIALIZING SYSTEM WHEN NQ=0.
C     ONLY NECESSARY WHEN ROUTING COEFS. ARE DIFFERENT FROM UNITY.
C
18    IF(NZ)32,32,22
22    DO 23 I=1,NPOINT
      IA(I)=0
23    A(I)=0.0
      L=1
      M=0
31    Q(L)=UNREG(L)
28    LL=NEXT(L)
      IF(NTYPE(LL)-4)25,26,27
25    Q(LL)=Q(L)+ UNREG(LL)
      L=LL
      GO TO 28
26    IA(LL)=IA(LL)+1
      IF(IA(LL)-1)29,29,30
29    A(LL)=Q(L)+2.0*UNREG(LL)
      M=M+1
      L=JUNC(M)
      GO TO 31
30    Q(LL)=A(LL)+ Q(L)
      L=LL
      GO TO 28
```

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```
   27   O(LL)=O(L)+ UNREG(LL)
   32   CONTINUE
        RETURN
        END
C
        SUBROUTINE CLT24 (IX,XXX)
        DIMENSION R(24)
C
C       IX=TRIGGER
C
C       XXX-RETURNING RANDOM NUMBER
C       RANDOM NUMBER GENERATOR
C
C       NOTE- THIS SUBROUTINE HAS BEEN CODED SPECIFICALLY FOR IBM 360/65.
C
        DO 1 I=1,24
        IY=IX*65539
        IF(IY)2,3,3
    2   IY=IY+2147483647 +1
    3   YFL=IY
        IX=IY
    1   R(I)=YFL*.4656613E-9
        DO 4 I=1,24
    4   SUM=SUM+R(I)
        X=SUM/1.41421-8.48526
        RETURN
        END
C
C
        SUBROUTINE SALT(NPOINT,INGRAN,FRANK,UNREG,NTYPE,ACONT,REGCO,
       1SESALT,TESALT,ISALT,ISALMP,FLOW,RN)
        DIMENSION FRANK(5,50),UNREG(50),NTYPE(50),ACONT(5,50),REGCO(5,50),
       1SESALT(5,50),TESALT(5,50),ISALMP(50),FLOW(50),RN(150)
C
CSAL
C
C       ARGUMENT DEFINITIONS
C
C       INFLOW. STATE DEFINITION OCCURS IN OTHER SUBROUTINES.- SEE AMBENT.
C
C       UNREG- LOCAL OR UNREGULATED INFLOWS INTO EACH COORD.   NET INFLOW.
C
C       NTYPE- NUMERIC DESCRIPTION OF EACH COORD.
C
C       ACONT- CONSTANT IN THE OPTIONAL EQUATIONS NOTED IN  REGCO.
C
C       REGCO- UNDER OPTION ISALT=1- SLOPE OF EXPON. EQ . RELATING CONCEN.
C       OF THE ITH CONSERVATIVE POLLUTANT TO LOCAL INFLOW FOR EACH COORD.
C       REGCO- UNDER OPTION ISALT=2- SLOPE OF LINEAR EQ.  RELATING CONCEN.
C       OF THE ITH COORD. TO A SPECIFIED QUALITY MONITORING STATION(ISALMP
```

```
C
C     SFSALT- UNDER OPTION ISALT=1- UPPER LIMIT OF CONCENTRATION FOR THE
C     ITH CONSERVATIVE POLL. AT THE JTH COORD.
C     SFSALT- UNDER OPTION ISALT=2- STD. ERR. OF ESTIMATE OF REGRESSION
C     EQ. RELATING CONCENTRATION AT ITH COORD. TO KTH MONITORING STATION
C     A RANDOM COMPONENT PROPOR. TO STD. ERR. EST. WILL BE ADDED TO
C     THE REGRESSED QUALITY.
C     IFSALT- FOR OPTIONISALT=1- LOWER LIMIT OF CONCEN. FOR THE ITH
C     CONSERVATIVE POLLUT. AT THE JTH COORD.-ISALT=2- NOT USED.
C
C     ISALT- KEY FOR COMPUTING CONSERVATIVE BACKGROUND CONCENTRATION.
C
C     ISALMP- UNDER ISALT=2- MAP RELATING ITH COORD. TO THE JTH WATER
C     QUALITY MONITORING STATION.THESE SIMULATED VALUES WILL BE INPUTTED
C     INTO FLOW. (NO ENTRY IN KGAGE AND ISALMP ARE THE SAME)
C
C     FLOW- HYDROLOGIC FLOWS AT GAGING STATIONS. ALSO UNDER ISALT=2 OPTI
C     FLOW WILL ALSO CONTAIN SIMULATED WATER QUALITY AT MONITORING STA.
C     THESE ARE INPUT EXOGENOUS DATA TO THE ROUTING.
C
C     RN- STORES RANDOM NUMBERS THAT WILL BE USED IN EACH FRAME.
C
C***** ISALT=1
      IF(ISALT-1)9,9,10
    9 DO 1 LO=1,NPOINT
      DO 1 IN=1,IRGRAN
      FRANS(IN,LO)=0.0
      IF(UNREG(LO))1,1,2
    2 Q=UNREG(LO)
      IF(LTYPE(LO)-4)3,4,3
C
C     LOCAL FLOW AT JUNCTION POINTS WAS PREVIOUSLY HALVED IN UNREGG.
C     NOTE-SEE SUBROUTINE UNREGG
C
    4 Q=2.0*Q
    3 QQ=ACONT(IN,LO)*(Q**REGCO(IN,LO))
      SF=SFSALT(IN,LO)
      IE=IFSALT(IN,LO)
      IF(QQ-SF)5,5,6
    6 QQ=SF
      GO TO 8
    5 IF(QQ-IE)7,7,8
    7 QQ=IE
    8 FRANS(IN,LO)=QQ
    1 CONTINUE
C*****
      GO TO 11
C***** ISALT=2
C
C     NOTE- WHEN USING ISALT=2- LIMITED TO ONE CONSERVATIVE POLLUT.
```

```
C
10    DO 12 LO=1,NPOINT
      IF(UNREG(LO))13,13,14
13    FRANK(1,LO)=0.0
      GO TO 12
14    IN=ISALMP(LO)
      CU=ALUM(1,LO)+REGCU(1,LO)*FLOW(IN)+SESALT(1,LO)*RN(LO)
      CU=AMAX1(0.0,CU)
12    FRANK(1,LO)=CU
C*****
11    RETURN
      END
      SUBROUTINE STORER(NDAMS,STSAVE,S,NFILL2,NFILL,NDRY,NDRY2,NSER,
     1NDEFY2,NDEFY,NDX2,NDX,NDX4,NDX3,OOLD2,OOLD,NWVBLS,DAMSAV,DAMCON,
     1AMBER2,AMBERI,IS,NPOINT)
      DIMENSION STSAVE(15),S(15),NFILL2(15),NFILL(15),NDRY(15),NDRY2(15)
     1,NDEFY2(25,12),NDEFY(25,12),NDX2 (25,6,12),NDX(25,6,12),
     2NDX4(25,6),NDX3(25,6),OOLD2(50),OOLD(50),DAMSAV(50,5),DAMCON(50,5)
     3,AMBERI(50,5),AMBER2(50,5)
C
C
C     NDAMS- NUMBER OF DAMS IN SYSTEM
C
C     STSAVE- SAVED VALUES OF STORAGE IN RESERVOIRS.
C
C     S- STORAGE IN RESERVOIRS. WORKING VECTOR.
C
C     NFILL2- SAVED VALUES OF NFILL
C
C     NFILL-COUNTS NUMBER OF TIMES RESERVOIRS SPILLED.- TIME INVARIANT.
C
C     NDRY- COUNTS NUMBER OF TIMES RESERVOIRS EMPTIED TO DEAD STORAGE.
C
C     NDRY2- SAVED VALUES OF NDRY.
C
C     NSER- NUMBER OF TEST AND JUNCTION POINTS IN SYSTEM
C
C     NDEFY2- SAVED VALUES OF NDEFY
C
C     NDEFY- COUNTER OF SEASONAL FAILURES TO MEET A FLOW TARGET OR WATER
C     QUALITY STANDARD AT ALL TEST POINTS AND JUNCTION POINTS.
C
C
C     NDX4- SAVED VALUES OF NDX3.
C     NDX3-COUNTER OF TIMES WHICH POLLUT. OR FLOW TARGET CAUSED
C     MAXIMUM EFFICIENCY OR FAILURE DURING ITH TIMEFRAME.
C
C     NDX2- SAVED VALUES OF NDX
      CONTINUE
C
```

```
C     NOX - COUNTER OF NUMBER OF TIMES JTH TARGET WAS VIOLATED DURING
C     THE ITH SEASON AT THE KTH TEST SITE.
C
C     QOLD2- SAVED VALUES OF QOLD
C
C     QOLD-SYSTEM FLOW FROM THE PREVIOUS TIMEFRAME.USE ONLY APPLICABLE
C     WHEN THE ROUTING COEF. ARE NON-UNITY.
C
C     NWVBLS- NUMBER OF POLLUTANTS (DEGRADABLE,CONSERVATIVE,UNSPECIFIED)
C
C     DAMSAV- SAVED VALUES OF DAMCON.
C
C     DAMCON- CONCENTRATION OF JTH WASTE IN ITH DAM. CONCENTRATIONS AT
C     END OF ITH FRAME ARE BEGINING CONCENTRATIONS OF (I+1)TH FRAME.
C
C     AMBEN2- SAVED VALUES OF AMBENT.
C
C     AMBENT- SYSTEM CONCENTRATION OF JTH POLLUT. AT ITH COORD.
C
C     IS- SEASONAL INDEX
C
C     NPOINT- NUMBER OF COORDINATES IN SYSTEM
C
C     STORING OF BEGINNING STATE CONDITIONS FOR CERTAIN PARAMETERS.
C     NECESSARY BECAUSE PROGRAM ATTEMPTS TO ITERATIVELY SATISFY DEMANDS.
C     NOTE- SAVING OF STATE IS NOT NECESSARY WHEN THE RESERVOIRS
C     ONLY OPERATE BY INPUT RULE CURVES OR EXPLICIT DIVERSIONS.
C
      IF(NDAMS)1,1,2
    2 DO 3 I=1,NDAMS
      STSAVE(I)=S(I)
      RDRY2(I)=RDRY(I)
    3 NFILL2(I)=NFILL(I)
    1 DO 4 I=1,NSER
      NDEFY2(I,IS)=NDEFY(I,IS)
      DO 4 J=1,6
      NOX2(I,J,IS)=NOX(I,J,IS)
    4 NOX4(I,J)=NOX3(I,J)
      DO 5 I=1,NPOINT
      QOLD2(I)=QOLD(I)
      IF(NWVBLS)5,5,6
    6 DO 7 J=1,NWVBLS
      DAMSAV(I,J)=DAMCON(I,J)
    7 AMBEN2(I,J)=AMBENT(I,J)
    5 CONTINUE
      RETURN
      END
      SUBROUTINE FRAMUP(IS,NSEAS,NSER,YRSUM,IWATER,DEFY,FLODIR,REQU,
     1NDAM,FLOOUL,NWVBLS,NDAMS,QSUP,ITER,DEFMAX)
      DIMENSION YRSUM(25),IWATER(25),DEFY(25,6),FLODIR(50),REQU(50),
```

```
     1INDAM(50),FLOQUL(50,5),QSUP(15),DEFMAX(25)
C
C     ARGUMENT DEFINITIONS
C
C     IS- SEASONAL INDEX
C
C     NSEAS- NUMBER OF SEASONS ( TIME FRAMES PER YEAR)
C
C     NSEK- NUMBER OF TEST AND JUNCTION POINTS IN SYSTEM
C
C     YRSUR- ACCUMULATES SEASONAL FAILURES OF A YEARLY BASIS FOR TEST
C     SITES, NO REGARD FOR PERSISTENCE.
C
C     IWATER- KEY TO KEEP TRACK OF WHICH WATER QUALITY STANDARD OR FLOW
C     TARGET IS MOST VIOLATED AT EACH OF THE TEST SITES.
C     FOR A FLOW TARGET THAT IS A DIVERSION OUT OF SYSTEM. KEY=7.
C
C     DEFY- DEFICIENCY FOR EACH TARGET FOR ALL TEST SITES.
C
C     FLODIR-EXPLICIT AND CONDITIONAL DIVERSION WATERS TO TEST SITES(CO)
C
C     REQ- SUPPLEMENTAL WATERS TO BE RELEASED FROM DAMS TO SATISFY
C     DOWNSTREAM USERS SPECIFIED BY NSERVE AND KSERVE.
C
C     INDAM- ACTIVE OR AVAILABLE RESERVOIR KEY (BY COORD.)
C
C     FLOQUL- STATE QUALITY OF THE EXPLICIT CONDITIONAL DIVERSION WATERS
C
C     NXVRLS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
C
C     NDAMS- NUMBER OF DAMS IN SYSTEM
C
C     QSUP- WATERS TO BE CONDITIONALLY DIVERTED BY DAMSITES.
C
C     ITER- CURRENT ITERATION INDEX
C
C     DEFMAX- MAXIMUM DEFICIENCY AT EACH TEST SITE DURING ITH SEASON.
C
C
C     CLEAN OUT FRAME WORKING MATRICES.
C
      DO 1 IJ=1,NSEK
      DEFMAX(IJ)=0.0
      IWATER(IJ)=0
      DO 1 NW=1,6
    1 DEFY(IJ,NW)=0.0
      DO 2 ID=1,50
      FLODIR(ID)=0.0
      DO 2 NW=1,5
    2 FLOQUL(ID,NW)=0.0
```

```
      IF(ITER-1)3,3,4
C
C     ONLY CLEANED OUT FOR INITIAL ITERATION.
C
3     DO 5 ID=1,50
      REDHI(ID)=0.0
5     IDDAM(ID)=1
      DO 6 IDAM=1,NDAMS
6     DSUP(IDAM)=0.0
      IF(IS-1)4,7,4
7     DO 9 I=1,ISER
9      YRSUP(I)=0.0
4     CONTINUE
      RETURN
      END
      SUBROUTINE EXTPNT(UNREG,LOCN,KEYBOD,AMBENT,INGRAN,FRANK,BODCON,QQ)
      DIMENSION UNREG(50),AMBENT(50,5),BODCON(50),FRANK(5,50)
     1,QQ(50)
C
C     INITIALIZES FLOW AND CONCENTRATIONS AT EXTREME CO-ORDS.(UPPERMOST
C     CO-ORDS. ON TRIB.)
C
C
C     ARGUMENT DEFINITIONS
C
C     UNREG-LOCAL INFLOW INTO ECH CO-ORD.
C
C     LOCN- CO-ORD. INDEX
C
C     KEYBOD- DEGRADABLE POLLUTANT KEY
C
C     AMBENT- SYSTEM CONCENTRATIONS AT ALL CO-ORDS.
C
C     INGRAN- NUMBER OF CONSERVATIVE POLLUTANTS
C
C     FRANK-BACKGROUND CONSERVATIVE POLLUTANT CONCENTRATIONS FOR ALL
C     LOCAL INFLOWS.
C
C     BODCON-BACKGROUND CONCENTRATIONS OF DEGRADABLE POLLUTANT FOR ALL
C     LOCAL INFLOWS.
C
C     QQ- SYSTEM FLOWS FOR ALL CO-ORDS.
C
C
      IF (UNREG(LOCN))1,1,2
2     IF (KEYBOD)3,3,4
4     AMBENT(LOCN,KEYBOD)=BODCON(LOCN)
3     IF (INGRAN)1,1,5
5     DO 6 ING=1,INGRAN
      IOS=ING+KEYBOD
```

```
      IOS=MINO(IOS,5)
    6 AMBENT(LOCN,IOS)=FRANK(ING,LOCN)
    1 OO(LOCN)=UNREG(LOCN)
      RETURN
      END
      SUBROUTINE WASTE(NNVALS,LOCN,IS,UNREG,OUT,AVWO,SDWO,RN,NWASTE,
     1FLOWIN,FLCMIN,AVCONC,SDCONC,OO,AMBENT,NPOINT,IWASTE)
      DIMENSION UNREG(50),AVWO(10,1,12),SDWO(10,1,12),RN(150),FLOWIN(10)
     2,FLCMIN(10,5),AVCONC(10,5,12),SDCONC(10,5,12),OO(50),AMBENT(50,5)
      DIMENSION FLUX(5)
C
C     ARGUMENT DEFINITIONS
C
C     NNVALS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
C
C     LOCN- CO-ORD. CURRENTLY UNDER CONSIDERATION.
C
C     IS- SEASONAL INDEX
C
C     UNREG- LOCAL OR UNREGULATED INFLOWS INTO EACH COORD.   NET INFLOW.
C
C     OUT-ROUTED FLOW TO THIS CO-ORD. NOTE- IF ROUTING COEF. FOR CO-ORD.
C     DIRECTLY ABOVE IS UNITY, THEN OO(LOCN) AND OUT ARE BOTH EQUAL.
C
C     AVWO- MEAN WASTE VOLUME OF ALL POLLUTANTS AT SITE(IWASTE),SEASON(I
C
C     SDWO- STD. DEV. WASTE VOLUME AT WASTE SITE(IWASTE),SEASON(IS)
C
C     RN- STORAGE OF RANDOM NUMBERS USED FOR EACH TIMEFRAME.
C
C     NWASTE- NUMBER OF WASTE SITES IN SYSTEM
C
C     FLOWIN- MINIMUM WASTE FLOW AT WASTE SITE J- TIME INVARIANT
C
C     FLCMIN- MINIMUM WASTE WEIGHT- SITE I POLLUTANT J)  TIME-INVARIANT
C
C     AVCONC- MEAN POLLUTANT WEIGHT,SITE(IWASTE),POLLUTANT(NW),SEASON(IS
C
C     SDCONC-STD. DEV. POLLUT. WT., SITE(IWASTE),POLLUT.(NW),SEASON(IS)
C
C     OO-SYSTEM FLOWS
C
C     AMBENT- SYSTEM CONCENTRATIONS.
C
C     NPOINT- NUMBER OF COORD. IN SYSTEM
C
C
C     IWASTE-WASTE SITE INDEX
C
      IF(NNVALS)1,1,2
```

```
2     NNW=IWASTE+NPOINT
C
C     ADDING RANDOM COMPONENT TO MEAN WASTE VOLUME.
C
      FLOWW=AVWO(IWASTE,1,IS)+SDWO(IWASTE,1,IS)*RN(NNW)
C
C     CONSTRAINING RANDOM FLUCTUATION WITH LOWER BOUND.
C
      EXTRA=AMAX1(FLOWW,FLOMIN(IWASTE))
      DO 3 NW=1,NWVBLS
      NNW=NWASTE +(IWASTE-1)*NWVBLS + NW+NPOINT
C
C     SAME FOR FLUX
C
      FLUXNW=AVCONC(IWASTE,NW,IS)+SDCONC(IWASTE,NW,IS)*RN(NNW)
3     FLUX(NW)=AMAX1(FLUXNW,FLCMIN(IWASTE,NW))
C
C     ADDING WASTE VOLUME TO STREAM FLOW
C
      OO(LOCN)=OO(LOCN)+EXTRA
C
C     BLENDING WASTE
C
      IF(OO(LOCN))5,5,6
5     DO 7 NW=1,NWVBLS
7     AMBENT(LOCN,NW)=0.0
      GO TO 1
6     DO 4 NW=1,NWVBLS
      AMB=(AMBENT(LOCN,NW)*(UNREG(LOCN)+OUT)+FLUX(NW))/OO(LOCN)
4     AMBENT(LOCN,NW)=AMAX1(AMB,0.0)
1     CONTINUE
      RETURN
      END
C
      SUBROUTINE DAMSET(AVAIL,S,IDAM,OO,IS   ,NWVBLS,AMBENT,DAMCON,KEYBOD
     1,NSEAS,TEMR,OXYDAM,LODAM,IEVAP,IDAMEV,IRFEV,NWASTE,NSER,RN,FACEVP,
     2EVPXX,EVPSD,ACOEVP,XCOEVP,CAP)
      DIMENSION S(15),OO(50),AMBENT(50,5),DAMCON(50,5),TEMR(12),
     1OXYDAM(15),LODAM(15),IDAMEV(15),IRFEV(15),RN(150),FACEVP(15),
     2EVPXX(3,12),EVPSD(3,12),ACOEVP(15),XCOEVP(15),CAP(15)
C
C     ARGUMENT DEFINITIONS
C
C     AVAIL-SUM OF STORAGE FROM END OF PREVIOUS MONTH PLUS CURRENT MONTH
C     INFLOW.
C
C     S-TOTAL CURRENT STORAGE IN RESERVOIR
C
C     IDAM- DAM COUNTER INDEX. UPDATED AS RESERVOIRS ARE ENCOUNTERED.
C
```

```
C     QO-SYSTEM FLOW DIRECTLY DOWNSTREAM OF DAM.
C
C     IS-SEASONAL INDEX
C
C     NOVBLS- NUMBER OF POLLUTANTS.
C
C     AMBENT-SYSTEM CONCENTRATIONS- AT THE RESERVOIR AND OF ALL RELEASES
C
C     DAMCON-CONCENTRATION OF STORAGE IN RESERVOIR- CARRIED FROM FRAME
C     TO FRAME.
C
C     KEYBOD- DEGRADABLE POLLUTANT KEY
C
C     NSEAS- NUMBER OF  SEASONS
C
C     TEMR- MEAN SEASONAL TEMPERATURE (C)- FOR BASIN- SPACE-INVARIANT.
C
C     OXYDAM- DECAY COEF. FOR DAMSITES. (LOG10-20 DEG. CENT.)
C
C     LODAM-MAP RELATING DAM INPUT ORDER TO DAM COORD NUMBER.  THE
C     (IDAM)TH ENTRY IS ITS COORD. NUMBER.
C
C     IEVAP- EVAPORATION OF RESERVOIR STORAGE KEY
C
C     INEEV- MAP RELATING EACH DAM(INPUT ORDER) TO REGIONAL EVAP. VEC.
      CONTINUE
C
C     NWASTE- NUMBER OF WASTE SITES IN SYSTEM
C
C     NSER- NUMBER OF TEST AND JUNCTION POINTS IN SYSTEM
C
C     RN- STORAGE OF RANDOM NUMBERS.
C
C     FACEVP-FACTOR TO SCALE THE REGIONAL EVAPORATION RATE TO THAT AT
C     THE DAMSITE. NOTE ENTRY IS DAM INPUT ORDER.
C
C     EVPAM- SEASONAL(IS) MEAN EVAPORATION RATE , ITH VECTOR
C
C     EVPSD- SEASONAL(IS) STD. DEVNS. OF EVAPORATION RATE, ITH VECTOR
C
C     ACOEVP- CONSTANT IN LINEAR EQU. RELATING AREA TO VOLUME FOR
C     EACH DAMSITE. OTHER FUNCTIONS CAN BE USED IF NEED BE.
C
C     XCOEVP- SLOPE FOR LINEAR EQU. RELATING AREA TO VOLUME. (EACH DAM)
C
C     CAP- CAPACITY OF RESERVOIR.
C
      IOD=LODAM(IDAM)
C
C     TOTAL ASSETS
```

```
C
      AVAIL=S(IDAM)+QQ(LOD)
      IF(CAP(IDAM))1,1,2
    2 IF(AVAIL)1,1,3
C
C     MIXING OF FLOW INTO THE RESERVOIR WITH CONTENTS
C
    3 IF(NWVBLS)4,4,5
    5 DO 6 NW=1,NWVBLS
      AMBENT(LOD ,NW)=(AMBENT(LOD ,NW)*QQ(LOD )+DAMCON(LOD ,NW)*S(IDAM))
     1/(QQ(LOD )+S(IDAM))
    6 DAMCON(LOD ,NW)=AMBENT(LOD,NW)
C
C     DEGRADING OVER HALF SEASON -AD HOC ASSUMPTION
C
      IF(KEYBOD)1,1,7
    7 FNSEAS=NSEAS
      TIMDAY=(365.0/FNSEAS)*0.5
C
C     MAKE TEMPERATURE STOCHASTIC AT SOME FUTURE TIME
C
      TED=TEMP(IS)-20.0
      OXYD=OXYDAM(IDAM)*(1.047**TED)
      E=2.7301
      AMB=AMBENT( LOD,KEYBOD)*(E**(-OXYD*TIMDAY))
      AMBENT( LOD,KEYBOD)=AMAX1(AMB,0.0)
      DAMCON( LOD,KEYBOD)=AMBENT( LOD,KEYBOD)
    4 IF(IEVAP)1,1,8
C
C
C     EVAPORATION OPTION
C
    8 CALL EVAP(  IDAM,AVAIL,IDAMEV,IKFEV,NWASTE,NWVBLS,NSER,RN,FACEVP,
     1EVPXM,EVPSD,ACOEVP,XCOEVP,AMBENT,DAMCON, LOD,NPOINT,IS,CAP)
    1 RETURN
      END
      SUBROUTINE EVAP(  IDAM,AVAIL,IDAMEV,IKFEV,NWASTE,NWVBLS,NSER,RN,
     1FACEVP,EVPXM,EVPSD,ACOEVP,XCOEVP,AMBENT,DAMCON, LOD,NPOINT,IS,CAP)
      DIMENSION IDAMEV(15),IKFEV(15),RN(150),FACEVP(15),EVPXM(3,12
     1),EVPSD(3,12),ACOEVP(15),XCOEVP(15),AMBENT(50,5),DAMCON(50,5)
     2,CAP(15)
C
C
C     ARGUMENT DEFINITIONS
C
C     IDAM-DAM NUMBER INDEX
C
C     AVAIL- TOTAL ASSETS-(INFLOW PLUS START OF SEASON STORAGE)-ENTERING
C     SUBROUTINE  LEAVING SUBROUTINE - ASSETS + OR -  (EVAP. OR RAIN)
C     NOTE OF CAUTION- IF EVAP. OR RAINFALL IS USED AS THE PROGRAM IS
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C     CURRENTLY CODED, THE TIME STREAM OF EVAP. IS INDEPENDENT OF THE
C     REGIONAL HYDROLOGICAL  CORRELATION STRUCTURE.
C
C     IDAMEV- MAP OF RESERVOIRS WHOSE STORAGE IS TO BE EVAPORATED.
C
C     IREEV- MAP RELATING EACH DAM(INPUT ORDER) TO REGIONAL EVAP. VEC.
C
C     NWASTE- NUMBER OF WASTE SITES.
C
C     NUVBLS- NUMBER OF POLLUTANTS.
C
C     NSER- NUMBER OF TEST SITES.
C
C     RN- STORAGE OF RANDOM NUMBERS.
C
C     FACEVP-FACTOR TO SCALE THE REGIONAL EVAPORATION RATE TO THAT AT
C     THE DAMSITE. NOTE ENTRY IS DAM INPUT ORDER.
      CONTINUE
C
C     EVPXB-SEASONAL(IS) MEAN EVAPORATION RATE , ITH VECTOR
C
C     EVPSD- SEASONAL(IS) STD. DEVNS. OF EVAPORATION RATE, ITH VECTOR
C
C     ACOEVP- CONSTANT IN LINEAR EQU. RELATING SURFACE AREA TO VOLUME F
C     EACH DAMSITE
C
C     XCOEVP- SLOPE FOR LINEAR EQU. RELATING AREA TO VOLUME. (EACH DAM)
C
C     AMBENT- SYSTEM CONCENTRATIONS. NOTE FOR DAMSITES, THESE ARE
C     CONCENTRATIONS OF THE WATERS TO BE RELEASED.
C
C     DAMCON- CONCENTRATIONS OF POLLUTANTS IN RESERVOIRS.
C
C     LOD- CURRENT CO-ORD. OF DAMSITE.
C
C     NPOINT- NUMBER OF CO-ORDS, IN SYSTEM
C
C     IS- SEASONAL INDEX
C
C     CAP- CAPACITIES OF RESERVOIRS.
C
C
C     CARE SHOULD BE EXERCISED IN USING THIS OPTION.
C     GENERALLY IT IS NOT RECCOMENDED.
C
      IF(AVAIL)1,1,2
C
C     MAP REFERRING DAM TO EVAP. VECTOR.
C
2     IF (IDAMEV(IDAM))1,1,3
```

```
3     JDAM=IRFEV(IDAM)
C
C     RANDOM NUMBER INDEX.
C
      NEVP=NWASTE*(I+NWVBLS)+NSER+IDAM+NPOINT
C
C     ASSUMPTION- ONLY THAT STORAGE THAT CAN BE CAUGHT BY THE RESERVOIR
C     WILL EXPERIENCE EVAP..
C
      VAIL=AMIN1(CAP(IDAM),AVAIL)
      IRAIN=0
      IF(EVPXM(JDAM,IS))10,12,12
C
C     RAINFALL - ADDING STORAGE.
C
10    IRAIN=1
      EVPXM(JDAM,IS)=-EVPXM(JDAM,IS)
      EVPSD(JDAM,IS)=-EVPSD(JDAM,IS)
C
C     ASSUMPTION- AREA OVER WHICH RAIN WILL FALL IS INDEPENDENT OF
C     CURRENT STORAGE LEVEL IN RESERVOIR.
C     CALCULATION IS BASED UPON TOTAL AREA.
C     THIS AREA SHOULD NOT BE INCLUDED AS PART OF THE UNREGULATED
C     INFLOW TO THE DAMSITE IF BOTH RAINFALL ADDITION AND EVAPORATION
C     DEPLETION ARE CONSIDERED.
C
      AREA=ACOEVP(IDAM)+XCOEVP(IDAM)*CAP(IDAM)
      GO TO 11
12    AREA=ACOEVP(IDAM)+XCOEVP(IDAM)* VAIL
C
C     RATE OF EVAP.- STOCHASTIC COMPONENT PROPORTIONAL TO STD.DEVN.
C
11    FTEVP=FACEVP(IDAM)*(EVPXM(JDAM,IS)+RN(NEVP)*EVPSD(JDAM,IS))
      FTEVP=AMAX1(FTEVP,0.0)
      DELVOL=FTEVP*AREA
      IF(IRAIN)13,13,14
14    DELVOL=-DELVOL
      EVPXM(JDAM,IS)=-EVPXM(JDAM,IS)
      EVPSD(JDAM,IS)=-EVPSD(JDAM,IS)
13    AVL=AVAIL-DELVOL
      AVL=AMAX1(AVL,0.0)
      IF(AVL)4,4,7
7     IF(NWVBLS)4,4,5
5     NWF=1
      IF(KEYBOD)15,15,16
16    NWF=2
C
C     ADJUSTING CONCENTRATION OF POLLUTANTS FOR EVAP. EFFECT.
C     DEGRADABLE IS NOT INCLUDED.
C
```

```
15    DO 6 NWW=NWE,NWVBLS
      AMBENT(LOD,NWW)=AMBENT(LOD,NWW)*(AVAIL/AVL)
6     DAMCON( LOD,NWW)=AMBENT( LOD,NWW)
4     AVAIL=AVL
1     CONTINUE
      RETURN
      END
      SUBROUTINE DAMGO(AVAIL,S,IDAM,ITRDIV,IS,ITRAN,DEAD,CAP,FLODIR,
     1NWVBLS,FLOQUL,DAMCON,DEFTMP,DEFB,DEFC,IPIPE,ITPPIP,QSUP,REQU,LODAM
     2,OO,NFILL,NDRY,TRADIR,INDAM)
      DIMENSION S(15),ITRAN(15),DEAD(15),CAP(15),FLODIR(50),FLOQUL(50,5)
     1,DAMCON(50,5),DEFTMP(15,12),DEFB(15,12),DEFC(15,12),ITPPIP(15),
     2QSUP(15),REQU(50),LODAM(15),OO(50),NFILL(15),NDRY(15),TRADIR(15,12
     3),INDAM(50)
C
C     ARGUMENT DEFINITIONS
C
C     AVAIL- TOTAL ASSETS-SEE SUBROUTINE DAMGO
C
C     S- CURRENT STORAGE IN RESERVOIR.
C
C     IDAM- DAM COUNTER INDEX
C
C     ITRDIV- EXPLICIT DIVERSION KEY
C
C     IS- SEASONAL INDEX
C
C     ITRAN- LOCATION OF THE TEST POINT THAT DAM(I) IS TO DELIEVER WATER
C     TO. THIS IS THE EXPLICIT DIVERSION OPTION. DIMENSION OF ITRAN IS 1
C
C     DEAD- MINIMUM POOL STORAGE IN EACH RESERVOIR.
C     E.G. VOLUME OF STORAGE BELOW OUTLET IPIPE, RECREATIONAL POOL VOL.
C
C     CAP- CAPACITY OF EACH RESERVOIR (UNITS MUST BE INPUT COMPATIBLE
C     WITH STREAMFLOW,WASTE FLOW ,TARGETS,ETC
C
C     FLODIR- STORES DIVERSION WATERS THAT ARE MIXED AND BLENDED WITH
C     STREAM FLOW AT TEST SITES IN SUBROUTINE TESDIR.
C     THE DIVERSIONS ARE STORED IN FLODIR BY TEST SITE CO-ORD. NUMBER.
C
C     NWVBLS- NUMBER OF POLLUTANTS (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
      CONTINUE
C
C     FLOQUL- CONCENTRATIONS OF THE DIVERSION WATERS.
C
C     DAMCON- CONCENTRATION OF JTH POLL. IN ITH DAM. CONCENTRATIONS AT
C     END OF ITH FRAME ARE BEGINING CONCENTRATIONS OF (I+1)TH FRAME.
C
      CONTINUE
C     GENERAL FORM OF INPUT RESERVOIR RULE CURVES.
```

```
C     DRAFT(IS)=A(IS) + B(IS)*INFLOW(IS) + C(IS)* STORAGE(IS-1)
C
C     DEFTMP = A. WHEN B(IS) AND C(IS) ARE ZERO AND A(IS) IS LESS THAN
C     ZERO, THEN A(IS) IMPLIES A FRACTIONAL CAPACITY VOLUME RULE.
C
C     DEFB = B
C
C     DEFC= C
C
C     IPIPE- CONDITIONAL DIVERSION KEY
C
C     ITPPIP- COORD. OF TEST POINT THAT THE ITH DAM IS TO MAKE A
C     CONDITIONAL DIVERSION FOR WATER QUALITY OR FLOW REQUIREMENT
C     DEFICIENCY.
C
C     QSUP- QUANTITIES OF CONDITIONAL RELEASES THAT DAMS ARE TO MAKE.
C     SEE SUBROUTINE SEARCH
C     QUANTITIES ARE STORED IN QSUP BY DAM INPUT ORDER.
C
C     REQU-RELEASES FOR DOWN STREAM PRE-SPECIFIED WATER USERS.
C     REQU- DOWNSTREAM PRE-SPECIFIED(NSERVE) WATER USER DEMANDS.
C
C     LODAM-MAP OF DAMSITES VS THEIR CO-ORD. NUMBERS.
C
C     QQ- SYSTEM FLOW DIRECTLY BELOW RESERVOIR.
C
C     NFILL-COUNTS NUMBER OF TIMES RESERVOIRS SPILLED.- TIME INVARIANT.
C
C     MDRY- COUNTS NUMBER OF TIMES RESERVOIRS EMPTIES TO DEAD STORAGE.
C
C     TRADIR- SEASONAL EXPLICIT DIVERSION QUANTITY FOR THE ITH DAM.
C
C
C
      LOD=LODAM(IDAM)
      IF(CAP(IDAM))1,1,2
1     QQ(LOD)=AVAIL
      GO TO 3
2     DRAFT=0.0
      SPILL=0.0
      C=0.0
      D=0.0
      STLEV=0.0
C
C****
C
C     EXPLICIT TRANSBASIN DIVERSION
C
C     NOTE- DIVERSION MADE FROM TOTAL AVAILABLE STORAGE.(LESS EVAP. LOSS
C     DIVERSION QUANTITY TEMPORARILY STORED IN FLODIR
```

```
C     MORE THAT ONE RESERVOIR CAN SEND A DIVERSION TO THE SAME TEST SITE
C
      IF(ITRDIV)4,4,5
5     IF(TRADIR(IDAM,IS))4,4,6
6     ITP=ITRAN(IDAM)
      B=AVAIL-DEAD(IDAM)
      A=TRADIR(IDAM,IS)
      C=AMIN1(A,B)
      AVAIL=AVAIL-C
      FLODIR(ITP)=FLODIR(ITP)+C
      IF(C)4,4,7
C     STATE QUALITY OF DIVERSION WATERS
C     NOTE-BLENDING OF QUALITY OF DIVERSION WATERS.
C     SEE SUBROUTINE TESDIR FOR BLENDING AND MIXING OF DIVERSION AT PRE-
C     SPECIFIED TEST SITE.
C
7     IF(NWVBLS)4,4,8
8     DO 9 NW=1,NWVBLS
9     FLOQUL(ITP,NW)=(FLODIR(ITP)*FLOQUL(ITP,NW)+C*DAMCON(LCD,NW))/
     1(C+FLODIR(ITP))
C
C****
C
C****
C
C     RELEASES BY PRE-SPECIFIED RULE CURVES.
C
C
4     IF(DEFC(IDAM,IS))10,10,11
10    IF(DEFB(IDAM,IS))12,12,11
12    IF(DEFTMP(IDAM,IS))13,14,11
13    STLEV=1.0
C
C
C     CHECKING FOR UNAVOIDABLE SPILL. BYPASSED WHEN GENERAL RELATIONSHIP
C     IS USED.(EXCEPT FOR THE POOL LEVEL CONSTRANT OPTION)
C
14    IF(AVAIL-CAP(IDAM))15,15,16
15    S(IDAM)=AVAIL
      GO TO 17
16    SPILL=AVAIL-CAP(IDAM)
      S(IDAM)=CAP(IDAM)
      DRAFT=DRAFT+SPILL
C
C     RESERVOIR FULL
C
17    IF(STLEV)18,18,19
C
C     POOL LEVEL OR ( OF CAPACITY RULE OPERATIVE
C
```

```
   19   STLEV=S(IDAM)/CAP(IDAM)
        IF(STLEV+DEFTMP(IDAM,IS))20,20,21
C
C       DEFTMP- INPUTE AS NEGATIVE FRACTION
C
   21   DRAFT=(STLEV+DEFTMP(IDAM,IS))*CAP(IDAM)
        S(IDAM)=S(IDAM)-DRAFT
        DRAFT=DRAFT+SPILL
        GO TO 18
C
C       GENERAL RULE RELEASE
C
   11   DRAFT=DEFTMP(IDAM,IS)+DEFB(IDAM,IS)*QQ( LOD)+DEFC(IDAM,IS)*S(IDAM)
C
C       IN MAPPING THE OPERATIONS FO EXISTING RESERVOIRS , EVAPORATION
C       WILL BE IMPLICITLY INCLUDED IN THE ABOVE RELATIONSHIP. THUS IT NEE
C       NOT BE DUPLICATED.
C
C       CONTINUITY CHECK
C
C       DRAFTS HAVE TO BE ZERO  OR POSITIVE.
C
        DRAFT=AMAX1(DRAFT,0.0)
        CHECK=AVAIL-DRAFT
        IF(CHECK-CAP(IDAM))20,20,22
C
C       CHECKING TO SEE IF STORAGE OVERBRINKS CAPACITY- ADJUSTMENT
C
   22   DRAFT=DRAFT+(CHECK-CAP(IDAM))
   20   IF(DRAFT)18,18,24
   24   S(IDAM)=AVAIL-DRAFT
C
C****
C
C****
C
C       CONDITIONAL DIVERSION WATERS
   18   IF(IPIPE)25,25,26
   26   IF(OSUP(IDAM))25,25,27
   27   LOSUP=ITPPIP(IDAM)
        A=S(IDAM)-DEAD(IDAM)
        D=AMIN1(A,OSUP(IDAM))
        S(IDAM)=S(IDAM)-D
C
C       NOTE- STORED IN FLODIR
C
        FLODIR(LOSUP)=FLODIR(LOSUP)+D
        IF(D)25,25,28
   28   IF(NRVELS)25,25,29
C
```

```
C      QUALITY OF CONDITIONAL DIVERSION WATERS.
C      NOTE- SEE SUBROUTINE TESDIR- DIVERSION WATERS ARE MIXED AND
C      BLENDED AT RECEIVING TEST POINT.
C      NOTE-RESERVOIR CAN SEND BOTH AN EXPLICIT AND CONDITIONAL DIVERSION
C      TO THE SAME TEST SITE.
C
29     DO 30 NW=1,NWVBLS
30     FLOQUL(LOSUP,NW)=(FLODIR(LOSUP)*FLOQUL(LOSUP,NW)+D*DAMCON(LOD,NW))
      1/(D+FLODIR(LOSUP))
C
C****
C
C****
C
C      DOWNSTREAM FLOW DEMANDS(REQU) FOR PRESPECIFED USERS(NSERVE,KSERVE)
C      SEE SUBROUTINE SEARCH
25     IF(REQU(LOD))31,31,32
32     TEMP=S(IDAM)-DEAD(IDAM)
       IF(REQU(LOD)-TEMP)33,33,34
33     S(IDAM)=S(IDAM)-REQU(LOD)
       DRAFT=DRAFT+REQU(LOD)
       GO TO 31
34     S(IDAM)=DEAD(IDAM)
       DRAFT=DRAFT+TEMP
C
C****
C
C
C      RELEASE TO NEXT DOWNSTREAM LOCATION
C
31     QO(LOD)=DRAFT
C
C      TALLYING SPILLS AND EMPTIES.
C
       DRAFT=DRAFT+C+D-SPILL
       IF(AVAIL-DRAFT-CAP(IDAM))35,35,36
36     NFILL(IDAM)=NFILL(IDAM) + 1
       GO TO 3
35     IF(S(IDAM)-DEAD(IDAM)) 37,37,3
37     NDRY(IDAM)=NDRY(IDAM)+1
C
C      DAM IS NO LONGER AVAILABLE FOR FURTHER RELEASES.
C
       IDDAM(LOD)=0
       IF(S(IDAM))38,38,3
38     IF(NWVBLS)3,3,39
39     DO 40 NW=1,NWVBLS
40     DAMCON(LOD,NW)=0.0
3      CONTINUE
       RETURN
```

```
      END
      SUBROUTINE FJUNC(JUNK,LOCN,OUTSAV,QO,OUT,NWVRLS,AMSAVE,AMBENT)
      DIMENSION JUNK(50),OUTSAV(50),QO(50),AMSAVE(50,5),AMBENT(50,5)
C
C
C     MIXES AND BLENDS FLOWS AND QUALITY AT JUNCTION POINTS.
C
C
C     ARGUMENT DEFINITIONS
C
C     JUNK- FLAG THAT SIGNALS WHETHER THE JTH JUCTION POINT HAS BEEN
C     ENCOUNTERED ONCE OR TWICE. IF 1 - FLOWS AND CONCENTRATIONS ARE
C     SAVED. THE PROGRAM THEN MOVES BY JUNC SPECIFICATION TO EXTREME
C     POINT OF OPPOSITE TRIBUTARY. IF 2- IMPLIES THAT JUNCTION POINT
C     HAS BEEN ENCOUNTERED TWICE , MIXING AND BLENDING TAKES PLACE.
C
C     LOCN- CURRENT CO-ORD. BEING CONSIDERED.
C
C     OUTSAV- SAVES SYSTEM FLOWS INTO JUNCTION POINTS.
C
C     QO- SYSTEM FLOWS AT ALL CO-ORD.
C
C     OUT- ROUTED FLOW FROM THE ITH CO-ORD TO (I+1)TH CO-ORD.
C
C     NWVRLS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
C
C     AMSAVE- SAVES SYSTEM CONCENTRATIONS OF SYSTEM FLOWS INTO JUNCTION
C     POINTS.
C
C     AMBENT- SYTEM CONCENTRATIONS AT ALL CO-ORD.
C
C
C     BLENDING CONCENTRATIONS OF THE TWO BRANCH FLOWS.
C
      IF(JUNK(LOCN)-1)1,1,2
C
C     THE OTHER BRANCH HAS NOT BEEN ENCOUNTERED YET.
C
C
C     OUTSAV- CONTAINS THE FLOW INTO THE JUNCTION FROM THE FIRST BRANCH.
C
    1 OUTSAV(LOCN)=QO(LOCN)
      OUT=0.0
      IF(NWVRLS)3,3,5
    5 DO 6 NN=1,NWVRLS
C
C     AMSAVE- CONTAINS THE SYSTEMS CONCENTRATIONS .
C
    6 AMSAVE(LOCN,NN)=AMBENT(LOCN,NN)
      GO TO 3
```

```
  2   IF(NWVALS)7,7,8
C
C     THE JUNCTION POINT HAS BEEN ENCOUNTERED TWICE.
C
  8   DO 9 NW=1,NWVALS
      IF(OO(LOCN)+OUTSAV(LOCN))10,10,11
 10   AMBENT(LOCN,NW)=0.0
      GO TO 9
C
C     BLENDING CONCENTRATIONS OF TWO BRANCH FLOWS.
C
 11   AMB=(ABSAVE(LOCN,NW)*OUTSAV(LOCN)+AMBENT(LOCN,NW)*OO(LOCN))/(OO(
     1LOCN)+OUTSAV(LOCN))
      AMBENT(LOCN,NW)=AMAX1(AMB,0.0)
  9   CONTINUE
C
C     MIXING OF TWO FLOWS.
C
  7   OO(LOCN)=OO(LOCN)+OUTSAV(LOCN)
  4   RETURN
      END
C
C
C
      SUBROUTINE TESDIR(ITRDIV,IPIPE,FLODIR,FLODUL,NWVALS,LOCN,OO,AMBENT
     1)
      DIMENSION FLODIR(50),FLODUL(50,5) ,AMBENT(50,5),OO(50)
C
C     ARGUMENT DEFINITIONS
C

C     ITRDIV-EXPLICIT DIVERSION KEY
C
C     IPIPE-CONDITIONAL DIVERSION KEY
C
C     FLODIR-TEMPORARY STORAGE OF CONDITIONAL AND EXPLICIT DIVERSION
C     WATERS THAT ARE TO BE ADDED AND BLENDED AT TEST SITES.
C
C     NWVALS- NUMBER OF POLLUTANTS
C
C     LOCN- CURRENT CO-ORD. BEING CONSIDERED.
C
C     OO- SYSTEM FLOW FOR ALL CO-ORD.
C
C     AMBENT-AMBIENT SYSTEM CONCENTRATIONS FOR EACH CO-ORD.
C
      IF(ITRDIV)3,3,7
  3   IF(IPIPE)1,1,7
  7   IF(NWVALS)4,4,5
C
```

```
C     MIXES AND BLENDS DIVERSION WATERS AT TEST SITES.
C
5     IF(FLODIR(LOCN)+QQ(LOCN))1,1,8
8     DO 9 NW=1,NNVBLS
9     AMBENT(LOCN,NW)=(AMBENT(LOCN,NW)*QQ(LOCN)+FLODIR(LOCN)*FLOQUL(LOCN
     1,NW))/(QQ(LOCN)+FLODIR(LOCN))
4     QQ(LOCN)=QQ(LOCN)+FLODIR(LOCN)
1     CONTINUE
      RETURN
      END
      SUBROUTINE TESTIP(DEFMAX,NNVBLS,AMBENT,QQ,CRIT,DEFY,IS,IWATER,NOX,
     1NWASTE,IJUNK,AVNEED,SDNEED,LOCN,IFLOD,ITPFLD,NOX3,RN,NPOINT,NDEFY)
      DIMENSION DEFMAX(25),AMBENT(50,5),QQ(50),
     1CRIT(25,5,12),DEFY(25,6),IWATER(25),NOX(25,6,12),AVNEED(25,12),
     2SDNEED(25,12),ITPFLD(25),NOX3(25,6),RN(150),NDEFY(25,12)
C
C     ARGUMENT DEFINITIONS
C
C
C     DEFMAX-MAX. FLOW DEFICIENCY FOR EACH TEST SITE.
C
C     NNVBLS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
C
C     AMBENT-SYSTEM CONCENTRATION FOR ALL POLLUTANTS FOR ALL CO-ORD.
C
C     QQ-SYSTEM FLOWS FOR ALL CO-ORD.
C
C     CRIT-WATER QUAL. STANDARD FOR TEST SITE(IJUNK),POLLUTANT(NW),
C     SEASON(IS)- STD. ORDER MUST BE SAME AS POLLUTANT ORDER.
C
C     DEFY-FLOW DEFICIENCY FOR EACH STANDARD AND FLOW TARGET FOR ALL
C     TEST SITES.
C
C     IS-SEASONAL INDEX
C
C     IWATER- KEY TO KEEP TRACK OF WHICH WATER QUALITY STANDARD OR FLOW
C     TARGET IS MOST VIOLATED AT EACH OF THE TEST SITES.
C
      CONTINUE
C     NOX - COUNTER OF NUMBER OF TIMES JTH TARGET WAS VIOLATED DURING
C     THE ITH SEASON AT THE KTH TEST SITE.
C
C     NWASTE- NUMBER OF WASTE SITES IN SYSTEM
C
C     IJUNK-TEST POINT AND JUNCTION POINT COUNTER INDEX
C     IJUNK IS UPDATED AS TEST AND JUNCTION(2ND PASS) ARE ENCOUNTERED.
C
C     AVNEED- MEAN FLOW REQUIREMENT AT TEST SITE(IJUNK),SEASON(IS)
C
C     SDNEED-STD. DEV. OF FLOW REQUIREMENT AT TEST SITE(IJUNK),SEASON(IS
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C
C     LOCN-CURRENT CO-ORD. BEING CONSIDERED.
C
C     IFLOW- CHANNEL CAPACITY MONITORING AT TEST POINT KEY
C
C     IFFLO- FLOOD MONITORING OPTION AT TESTPOINTS. CHECKS FOR EXCESS
C     FLOW RATHER THAN DEFICIENT FLOW . TARGET FLOWS WILL USUALLY BE
C     CHANNEL CAPACITIES. ENTERED IN AVNNEED.
C     NEXS-COUNTER OF TIMES WHICH POLLUT. OR FLOW TARGET CAUSED
C     MAXIMUM DEFICIENCY OR FAILURE DURING ITH TIMEFRAME.
C
C     RN- CONTAINS RANDOM NUMBERS THAT ARE USED DURING EACH TIMEFRAME.
C     NPOINT= NUMBER OF COORD. IN SYSTEM
C
C     NDEFY-COUNTER OF SEASONAL FAILURES TO MEET A FLOW TARGET OR WATER
C     QUALITY STANDARD AT ALL TEST SITES.
C
C
      IF(NOVALS)1,1,2
2     DO 3 NN=1,NOVALS
C
C     COMPARING CONCENTRATIONS TO WATER QUALITY STANDARDS
C
      IF(CRIT(IJUNK,NN,IS))4,4,5
C
C     ONE PERCENT TOLERANCE
C
5     TOL=0.01*CRIT(IJUNK,NN,IS)
      IF(AMOUNT(LOCN,NN)-CRIT(IJUNK,NN,IS)-TOL)4,4,6
4     DEFY(IJUNK,NN)=0.0
      GO TO 3
C
C     COMPUTE AMOUNT OF SUPPLIMENTAL FLOW.
C     SUPPLIMENTAL QUANTITIES ARE LOW- DILUTION WATERS HAVE ZERO
C     CONCENTRATIONS.
C
6     DEFY(IJUNK,NN)=100(LOCN)*(AMOUNT(LOCN,NN)-CRIT(IJUNK,NN,IS)))/CRIT
     1(IJUNK,NN,IS)
      IF(DEFY(IJUNK,NN)-0.5)7,7,8
7     DEFY(IJUNK,NN)=0.0
      GO TO 3
C
C     FINDING MAXIMUM DEFICIT
C
8     IF(DEFMAX(IJUNK)-DEFY(IJUNK,NN))9,10,10
9     DEFMAX(IJUNK)=DEFY(IJUNK,NN)
      IWATER(IJUNK)=NN
C
C     NDX COUNTS DIFFERENT KINDS OF DEFICIENCIES
C
```

```
 10   [illegible]Z(IJUNK,NW,IS)=NOX(IJUNK,NS,IS)+1
   1  CONTINUE
   1  [illegible]=0.0
      [illegible](I+NWVHLS)+IJUNK+MPOINT
      IF(AV[illegible](IJUNK,IS))11,12,13
C
C
C     DIVERSION COMPLETELY OUT OF SYSTEM.
C
 11   AW[illegible](IJUNK,IS)=-AVNEED(IJUNK,IS)
      S[illegible](IJUNK,IS)=-SUNEED(IJUNK,IS)
      [illegible](IJUNK,IS)+RN([illegible])*SUNEED(IJUNK,IS)
      [illegible]
      [illegible](IJUNK,IS)=-AVNEED(IJUNK,IS)
      [illegible](IJUNK,IS)=-SUNEED(IJUNK,IS)
      [illegible]
      [illegible]Y1=AMAX1(DEFY1,0.0)
C
C     [illegible] ZERO
C
      IF([illegible]Y1)15,15,16
 16   [illegible]=0.0
      GO TO 17
 15   [illegible]-WAT
      GO TO 17
C
C     [illegible] REQUIREMENT
C
 13   [illegible]=AVNEED(IJUNK,IS)+SUNEED(IJUNK,IS)*RN(NNR)
      [illegible](0.0,[illegible])
C
C     [illegible] CONSIDERATION
C
      IF([illegible])18,18,19
 19   IF([illegible])18,18,20
 20   [illegible]
      GO TO 17
 18   [illegible]
 17   DEFY(IJUNK,6)=AMAX1(DEFY1,0.0)
      IF(DEFY(IJUNK,6)-0.5)170,170,22
 170  DEFY(IJUNK,6)=0.0
      GO TO 12
 22   [illegible](IJUNK,6,IS)=N[illegible](IJUNK,6,IS)+1
      IF([illegible]MAX(IJUNK)-DEFY(IJUNK,6))23,12,12
 23   [illegible](IJUNK)=DEFY1
      IF([illegible])24,24,25
 24   [illegible](IJUNK)=6
      GO TO 12
 25   [illegible](IJUNK)=7
 12   IF([illegible]MAX(IJUNK))27,27,28
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C
C     TALLYING FAILURES
C     NOTE - IF NITER IS GREATER THAN ONE (MORE THAN ONE ITERATION) THEN
C     THE ENTRIES IN NDEFY AND NDX3 ARE TEMPORARY.
C     ONLY THE ENTRIES MADE FOR THE LAST ITERATION WILL BE KEPT.
C     SEE SUBROUTINE STORER AND RESTOR.
C
 28   NDEFY(IJUNK,IS)=NDEFY(IJUNK,IS)+1
      MDMAX=IWATER(IJUNK)
      MDMAX=MINO(MDMAX,6)
      NDX3(IJUNK,MDMAX)=NDX3(IJUNK,MDMAX)+1
 27   CONTINUE
      RETURN
      END
      SUBROUTINE TESCHK(DEFMAX,IJUNK,NS     ,IFLOD,ITPFLD,KSERVE,INDAM,
     1IPIPE,ITPPIP,NDAMS,SENSK,SEPIP,LODAM,LOCN)
      DIMENSION DEFMAX(25),NSERVE(25),ITPFLD(25),KSERVE(25,10),INDAM(50)
     1,ITPPIP(15),LODAM(15)
C
C     ARGUMENT DEFINITIONS
C
C
C     DEFMAX-MAX. FOW DEFICIENCY FOR EACH TEST SITE.
C
C     IJUNK-TEST POINT AND JUNCTION POINT COUNTER INDEX.
C
C     NSERVE- NUMBER OF DAMS TO MAKE AUGMENTATIONS FOR WATER USERS AT
C     TEST AND JUNCTION POINTS.  THESE ARE UPSTREAM FIRST TIER DAMS.
C
C     IFLOD- FLOOD MONITORING KEY
C
C     ITPFLD-FLOOD MONITORING MAP FOR TEST SITES.
C
C     KSERVE-LOCATIONS OF THE RESERVOIRS SERVING TEST AND JUNCTION POINT
C
C     INDAM-KEEPS TRACK OF RESERVOIRS(BY CO-ORD.) THAT EMPTY DURING ANY
C     PASS (ITERATION).
C
C     IPIPE- CONDITONAL DIVERSION KEY
C
C     ITPPIP- CO-ORD.  OF JTH TEST POINT THAT ITH DAM IS TO MAKE A
C     CONDITIONAL DIVERSION FOR A WATER QUALITY OR FLOW REQUIREMENT NEED
C
C     NDAMS - NUMBER OF DAMS IN SYSTEM
C
C     SENSK-NUMBER OF RESERVOIRS THAT CAN STILL BE CALLED UPON TO
C     SATISFY THE DEMANDS OF SPECFIED USERS.  USED ONLY WHEN NITER IS
C     GREATER THAN ONE.USED AS A FLAG.
C
C     SEPIP- USED THE SAME AS SENSK- FOR  CONDITIONAL DIVERSION ITERATION
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C
C     LODAM- MAP OF DAMS(PROGRAM ENCOUNTER ORDER) TO CO-ORD.
C
C     LOCN- CURRENT CO-ORD. BEING CONSIDERED.
C
      IF(NDAMS)1,1,2
2     IF(NFEMAX(IJUNK))1,1,3
3     IF(NSERVE(IJUNK))4,4,5
5     MSK=NSERVE(IJUNK)
C
C     TALLYING SENSK AND SEPIP FOR ITERATIVE SIGNAL.
C
      IF(MSK)4,4,6
6     FNSK=0.0
      DO 7 I=1,MSK
      KS=KSERVE(IJUNK,I)
      IF(IMDAM(KS))7,7,8
8     FNSK=FNSK+1.0
7     CONTINUE
      SENSK=SENSK+FNSK
4     IF(IPIPE)1,1,10
10    DO 11 I=1,NDAMS
      K=I
      IF(IIPPIP(I)-LOCN)11,12,11
11    CONTINUE
      GO TO 1
12    LOD=LODAM(K)
      IF(IMDAM(LOD))1,1,13
13    SEPIP=SEPIP+1.0
1     CONTINUE
      RETURN
      END
C
      SUBROUTINE ROUTE(NEXT,LOCN,OUT,OOLD,CR,OO,UNREG,NWVBLS,KEYBOD,
     1CONSTV,EXPV,TEMR,OXYHAS,AMBENT,BODCON,INGRAM,FRANK,FMIL,IS)
      DIMENSION NEXT(50),OOLD(50),CR(50),OO(50),UNREG(50),CONSTV(50),
     1EXPV(50),TEMR(12),OXYHAS(50),AMBENT(50,5),BODCON(50),FRANK(5,50)
     2,FMIL(50)
C
C
C     ROUTING FLOW DOWN TO NEXT CO-ORD. DEFINING BOTH SYSTEM FLOW AND
C     CONCENTRATION FOR NEXT CO-ORD. TO BE CONSIDERED.
C
C
C     ARGUMENT DEFINITIONS
C
C     NEXT- IMMED. DOWNSTREAM COORD. OF ITH COORD. PROCEEDING IN NUMERIC
C     ORDER.
C
C     LOCN- ENTERS AS CO-ORD. JUST CONSIDERED. EXITS OUT OF THE SUBROUTI
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```
C     AS CO-ORD. TO CONSIDER NEXT.
C
C     OUT- ROUTED FLOW FROM CO-ORD J TO CO-ORD. J+1.
C
C     OOLD- SYSTEM FLOWS DURING THE PREVIOUS TIME FRAME.
C     ONLY NECESSARY WHEN ROUTING COEFS. ARE LESS THAN ONE.
C
C     CR- GILCHIRST ROUTING COEF.- SET EQUAL TO 1
C
C     QO- SYSTEM FLOWS DURING THE CURRENT TIME FRAME.
      CONTINUE
C
C     QNREG- NET LOCAL INFLOWS INTO EACH CO-ORD.
C
C     NPVBLS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
C
C     KEYBOD- DEGRADABLE POLLUTANT KEY
C
C     CONSTV-CONSTANT IN EXPON. EQU. RELATING VELOCITY TO FLOW FOR EACH
C     COORD.-JTH ENTRY FOR ITH AND(I+1)TH COORD.
C
C     EXPV- SLOPE IN EXPON. EQU. RELATING VELOCITY TO FLOW.
C
C     TEMR- MEAN SEASONAL TEMPERATURE (C)- FOR BASIN- SPACE-INVARIANT.
C
C     OXYRAS- DECAY COEF. FOR DEGRAD.POLL. (LOG10-20DEG. CEN.)FOR ALL CO
      CONTINUE
C
C     AMBENT- SYSTEM CONCENTRATIONS OF ALL POLUTS. FOR ALL CO-ORDS.
C
C     BODCON- BACKGROUND CONCENTRATION OF DEGRADABLE POLLUTANT(KEYBOD=1)(
C     FOR LOCAL INFLOWS INTO EACH COORD.- TIME-INVARIANT.
C
C     INGRAN- NUMBER OF CONSERVATIVE POLLUTANTS
C
C     FRADK- CONCENTRATION OF ITH CONCERVATIVE POLLUT. FOR THE
C     INFLOW. STATE DEFINITION OCCURS IN OTHER SUBROUTINES.- SEE AMBENT.
C
C     RMIL- RIVER MILES BETWEEN EACH COORD. JTH ENTRY IS MILES BETWEEN
C     ITH AND (I+1)TH COORDS.
C
C
C     LOCATION OF NEXT DOWNSTREAM POINT.
C
      LOCN2=NEXT(LOCN)
C
C     MODIFIED GILCRIST ROUTINE EQUATION.
C
      OUT=OOLD(LOCN)+CR(LOCN)*(QO(LOCN)-OOLD(LOCN))
C
```

```
C     SAVING ITH FRAME FLOW FOR (I+1)TH FRAME CALCULATIONS.
C
      QOLD(LOCN)=QQ(LOCN)
C
C     QZIT- FLOW USED TO COMPUTE VELOCITY WHEN A DEGRADABLE HAS BEEN
C     SPECIFIED. ADDING HALF THE  LOCAL INFLOW IS ARBITUARY ASSUMPTION.
C
      QZIT=OUT+UNREG(LOCN2)*0.5
      IF(QZIT)1,1,2
2     IF(QQVBLS)1,1,3
3     IF(KEYBOD)4,4,5
C
C     CALCULATING VELOCTY.
C
5     VFPS=CONSTV(LOCN)*(QZIT**EXPV(LOCN))
      VMPD=16.4*VFPS
      IF(VMPD)6,6,7
6     TIMDAY=0.0
      GO TO 8
C
C     CALCULATING TIME OF TRAVEL,
C
7     TIMDAY=FMIL(LOCN)/VMPD
C
C     TEMPERATURE CORRECTION.
C
8     TEW=TEMK(IS)-20.0
      OXY=OXYUAS(LOCN)*(1.047**TEW)
      E=2.7301
C
C     DECAY CALCULATION.
C
      BODCAY=AMBENT(LOCN,KEYBOD)*(E**(-OXY*TIMDAY))
C
C     MIXING CONCENTRATION OF ROUTED FLOW WITH NATURAL BACKGROUND
C     CONCENTRATION OF LOCAL INFLOW. NOTE THAT BODCON IS TIME-INVARIANT.
C
      AMB=(OUT*BODCAY+BODCON(LOCN2)*UNREG(LOCN2))/(OUT+UNREG(LOCN2))
      AMBENT(LOCN2,KEYBOD)=AMAX1(AMB,0.0)
4     IF(INGRAN)9,9,10
C
C     COMPUTING CONCENTRATION OF CONSERVATIVE POLLUTANTS. NOTE - FRANK
C     CONTAINS BACKGROUND CONCENTRATIONS FOR ALL LOCAL(UNREGULATED) INFLO
C
10    DO 11 INI=1,INGRAN
      KOO=KEYBOD+INI
      KOO=MINO(KOO,5)
      AMB=(OUT*AMBENT(LOCN,KOO)+FRANK(INI,LOCN2)*UNREG(LOCN2))/(OUT+
     1UNREG(LOCN2))
11    AMBENT(LOCN2,KOO)=AMAX1(AMB,0.0)
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9     LMN=KEYBOD+INGRAN
      IF(LMN-NWVBLS)12,1,1
C
C     COMPUTING CONCENTRATION FOR UNSPECIFIED POLLUTANT(S)-
C     NOTE- UNREG HAS ZERO CONCENTRATION.
C
12    DO 13 NW=LMN,NWVBLS
      AMB = (OUT*AMBENT(LOCN,NW) /(UNREG(LOCN2) + OUT)
13    AMBENT(LOCN2,NW)=AMAX1(AMB,0.0)
C
C     DEFINING SYSTEM FLOW FOR NEXT DOWNSTREAM CO-ORD.
C
1     QO(LOCN2)=UNREG(LOCN2)+OUT
      LOCN=LOCN2
      RETURN
      END
C
      SUBROUTINE SEARCH(IPIPE,ITER,NSTART,NPOINT,NTYPE,DEFMAX,NDAMS,
     1ITPPIP,S,DEAD,IWATER,QSUP,JUNK,NEXT,SENSK,ITPFLD,NSERVE,KSERVE,
     2LODAM,REQU,IOPT,JUNC,LOJUNK,IFLOD)
      DIMENSION JUNK(50),NTYPE(50),DEFMAX(25),ITPPIP(15),S(15),DEAD(15),
     1IWATER(25),QSUP(15),NEXT(50),ITPFLD(25),NSERVE(25),KSERVE(25,10),
     1LODAM(15),REQU(50),QACUM(50),JUNC(10),LOJUNK(25)
C
C
C     ARGUMENT DEFINITIONS
C
C
C     IPIPE- CONDITIONAL DIVERSION KEY
C
C     ITER-RESERVOIR RELEASE ITERATION INDEX.
C
C     NSTART-CO-ORD. AT WHICH PROGRAM BEGINS ROUTING AT.
C
C     NPOINT- NUMBER OF COORD. IN SYSTEM
C
C     NTYPE- NUMERIC DESCRIPTION OF EACH COORD.
C
C     DEFMAX-MAXIMUM DEFICIENCY AT EACH TEST SITE.
C
C     NDAMS- NUMBER OF DAMS IN SYSTEM
C
C     ITPPIP-CO-ORD. OF TEST POINT THAT  ITH DAM IS TO MAKE A
C     CONDITION L DIVERSION FOR WATER QUALITY OR FLOW REQUIREMENT
C     DEFICIENCY.
      CONTINUE
C
C     S- ENTERING SUBROUTINE- STORAGE IN RESERVOIRS AT END OF ROUTING
C     SEQUENCE.
C     AT END OF ITER=1, THE RESERVOIRS HAVE MADE RELEASES FOR ONLY
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C     TRANSBASIN DIVERSIONS AND FOR THE INPUT OPERATING RULE  CURVES.
C     FOR ITER=2 OR THREE, RESERVOIRS HAVE MADE A PRIORI DIVERSIONS,
C     OPERATING RULE RELEASES, AND CONDITIONAL DIVERSIONS.
C     FOR ITER=4,5,OR 6- IN ADDTION, RELEASES FOR INSTREAM PRESPECIFIED
C     USERS HAVE BEEN MADE.
C     LEAVING SUBROUTINE- VALUES OF S ARE IMMATERIAL BECAUSE SUBROUTINE
C     RESTOR WHICH FOLLOWS WILL RE-INITIALIZE THE STORAGE IN RESERVOIRS
C     TO BEGINNING OF THE SEASON CONDITIONS.
C
C     DEAD- MINIMUM POOL STORAGE IN EACH RESERVOIR.
C
C     IWATER-FLAG THAT KEEPS TRACT OF WHICH POLLUTANT(1-5),INSTREAM
C     REQUIREMENT(6), OR INSTREAM DIVERSION(7) IS CONTROLLING.
C     ACTUALLY THE SWITCH IS (1-6) OR 7.
C
C     OSUP- AMT. OF WATER  TO BE RELEASED FOR CONDITIONAL DEIVERSIONS.
C     SEE SUBROUTINES DAMGO AND TESDIR
C
C     JUNK- FLAG THAT SIGNALS WHETHER JTH JUNCTION POINT HAS BEEN
C     ENCOUNTERED ONCE OR TWICE. IF 1- FLOWS ARE SAVED. THE PROGRAM THEN
C     MOVES BY JUNC SPECIFICATION TO EXTREME POINT OF OPPOSITE  TRIB.
C     IF 2- IMPLIES THAT JUNCTION POINT HAS BEEN ENCOUNTERED TWICE-
C     FLOWS FROM TWO BRANCHES ARE THEN COMBINED.
C
C     NEXT- INNED. DOWNSTREAM COORD. OF ITH COORD. PROCEEDING IN NUMERIC
C     ORDER.
C
C     SENSR-SIGNALS THAT RELEASES ARE NECESSARY TO SATISFY INSTREAM
C     PRESPECIFIED USER REQUIREMENTS AND THAT SOME (ALL) OF THE
C     PRESPECIFIED RESERVOIRS STILL HAVE AVAILABLE STORAGE TO DRAW UPON.
C
      CONTINUE
C     ITFLD- FLOOD MONITORING OPTION AT TESTPOINTS. CHECKS FOR EXCESS
C     FLOW RATHER THAN DEFICIENT FLOW . TARGET FLOWS WILL USUALLY BE
C     CHANNEL CAPACITIES. ENTERED IN AVNNEED.
C
C     NSERVE- NUMBER OF DAMS TO MAKE AUGMENTATIONS FOR WATER USERS AT
C     TEST AND JUNCTION POINTS.  THESE ARE UPSTREAM FIRST TIER DAMS.
C
C     KSERVE-LOCATIONS OF THE RESERVOIRS SERVING TEST AND JUNCTION POINT
C
C     LODAM-MAP RELATING DAM INPUT ORDER TO DAM COORD NUMBER.  THE
C     (IDAM)TH ENTRY IS ITS COORD. NUMBER.
C
C     REQU- AMT. OF WATER TO BE RELEASED IN NEXT ITERATION FROM
C     PRESPECIFIED RESERVOIRS (BY CO-ORD.) TO SATISFY DOWNSTREAM USERS.
C
C     IOPT- RELEASE RULES FOR ALLOCATING RELEASES TO SATISFY INSTREAM
C     DEMAND FROM A GROUP OF RESERVOIRS. SEE MAIN PROGRAM.
C
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C     JUNC- CO-ORD. OF EXTREME POINT ON TRIB. TO WHICH ROUTING WILL
C     PROCEED WHEN A JUNCTION POINT IS ENCOUNTERED.
C     LOJUNK- MAP RELATING TESTSITES TO CO-ORD. NUMBER.
      IF(IPIPE)1,1,2
2     IF(ITER-3)3,3,1
C
C
C     FINDING CONDITIONAL DIVERSION REQUIREMENTS. NOTE QUANTITY
C     DIVERTED FOR THE ITH TESTSITE IS CARRIED DOWNWARD WHEN DETERMINING
C     ADDITIONAL RELEASE FOR SATISFYING (I+1)TH TEST SITE.
C
3     NJUC=0
      MOLD=MSTART
      NOL=0
      QTRIB=0.0
      DO 5 I=1,NPOINT
      QACUM(I)=0.0
5     JUNK(I)=0
6     KK=NTYPE(NOLN)
      GO TO (7,10,10,9,1),KK
7     NOL=NOL+1
C
C     FLOOD MONITORING SITE. DEFICIENCY IS AN EXCESS.
C
      IF(IFLOD)700,700,701
701   IF(ITPFLD(NOL))700,700,10
700   IF(DEFMAX(NOL)-QTRIB)10,10,11
11    LJ=LOJUNK(NOL)
C
C     REDUCING MAXIMUM NEED BY AMOUNT QTRIB.
C
      DEFMAX(NOL)=DEFMAX(NOL)-QTRIB
      DO 12 I=1,NDAMS
      LIDAM=I
      IJ=ITPPIP(I)
      IF(IJ-LJ)12,13,12
12    CONTINUE
      GO TO 10
13    IF(S(LIDAM)-DEAD(LIDAM))10,10,14
14    IWT=IWATER(NOL)
      A=S(LIDAM)-DEAD(LIDAM)
      IF(IWT-6)16,16,17
16    B=AMIN1(A,DEFMAX(NOL))
      OSUP(LIDAM)=OSUP(LIDAM) + B
C
C     UPDATING AMOUNT CARRIED FORWARD.
C
      QTRIB=OSUP(LIDAM)+QTRIB
      GO TO 10
17    B=AMIN1(A,DEFMAX(NOL))
```

```
      QSUP(LIDAM)=QSUP(LIDAM) + B
C
C     DIVERSION IS TO SATISFY AN EXHAUST OUT OF SYSTEM.
C
      GO TO 10
C
C     JUNCTION POINT.
C
      JUNK(NOLN)=JUNK(NOLN)+1
      IF(JUNK(NOLN)-1)19,19,20
19    NJNC=NJNC+1
C
C     SAVE OF ACCUMULATED OTRIB.
C
      OACUM(NOLN)=OTRIB
      NOLN=JUNC(NJNC)
      OTRIB=0.0
      GO TO 6
C
C     COMBINING
C
20    OTRIB=OACUM(NOLN)+OTRIB
      GO TO 7
10    NOLN=NEXT(NOLN)
      GO TO 6
C
C     DETERMINING RELEASES TO SATISFY PRESPECIFIED USERS(NSERVE).
C     NOTE THAT QUANTITY TO BE RELEASED IS CARRIED FORWARD (DOWNWARD).
C
1     IF(SENSK)100,100,30
30    NJNC=0
      NOLN=NSTART
      NOL=0
      OTRIB=0.0
      DO 31 I=1,NPOINT
      OACUM(I)=0.0
31    JUNK(I)=0
32    KK=NTYPE(NOLN)
      GO TO (33,38,38,35,100),KK
33    NOL=NOL +1
C
C     FLOOD MONITORING
C
      IF(IFLOD)39,39,390
390   IF(ITPFLD(NOL))39,39,38
39    IF(DEFMAX(NOL)-OTRIB)38,38,40
40    DEFMAX(NOL)=DEFMAX(NOL)-OTRIB
      IF(NSERVF(NOL)-1)38,41,42
41    KS=KSERVF(NOL,1)
C
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```
C     RELEASE FROM ONE RESERVOIR SERVING USER.
C
      DO 43 I=1,NDAMS
      LOD=LODAM(I)
      JDAM=I
      IF(LOD-KS)43,44,43
43    CONTINUE
      GO TO 38
44    IF(S(JDAM)-DEAD(JDAM))38,38,45
45    A=S(JDAM)-DEAD(JDAM)
      B=AMIN1(DEFMAX(NOL),A)
      S(JDAM)=S(JDAM)-B
      REOU(LOD)=REOU(LOD)+B
      IF(IBATER(NOL)-7)46,38,38
46    OTRIB=OTRIB+B
      GO TO 38
C
C     ALLOCATING DEMAND AMONG A GROUP OF RESERVOIRS.
C
42    NS=NSERVE(NOL)
      SUMST=0.0
      FF=0.0
C
C     FINDING SUM OF AVAILABLE STORAGE AND COUNT OF (IN) RESERVOIRS.
C
      DO 47 J=1,NS
      KS=KSERVE(NOL,J)
      DO 48 I=1,NDAMS
      LOD=LODAM(I)
      IF(LOD-KS)48,49,48
49    IF(S(I)-DEAD(I))48,48,50
50    SUMST=SUMST+S(I)-DEAD(I)
      FF=FF+1.
48    CONTINUE
47    CONTINUE
      IF(FF)38,38,51
C     OPTIONS
C     1- SPLIT DEMAND EVENLY
C     2- SPLIT ACCORDING TO PERCENTAGE OF AVAILABLE STORAGE.(SPACE RULE)
C     3- SEQUENTIALLY DEPLETE BY ORDER SPECFIED IN KSERVE.
C
51    GO TO (52,53,54),IOPT
C
C     OPTION ONE
C
52    B=DEFMAX(NOL)/FF
      DO 55 J=1,NS
      KS=KSERVE(NOL,J)
      DO 56 I=1,NDAMS
      LOD=LODAM(I)
```

```
      IF(KS-LOD)56,57,56
57    IF(S(I)-DEAD(I))56,56,58
58    REQU(LOD)=REQU(LOD)+ B
      IF(S(I)-DEAD(I)-B)59,59,60
59    B=S(I)-DEAD(I)
      S(I)=DEAD(I)
      GO TO 61
60    S(I)=S(I)-B
61    IF(IWATER(NOL)-7)620,56,56
620   OTRIB=OTRIB+B
56    CONTINUE
55    CONTINUE
      GO TO 38
C
C     OPTION 2
C
53    IF(SUMST)38,38,62
62    DO 63 J=1,NS
      KS=KSERVE(NOL,J)
      DO 64 I=1,NOAMS
      LOD=LODAM(I)
      IF(KS-LOD)64,65,64
65    IF(S(I)-DEAD(I)) 64,64,66
66    B=DEFMAX(NOL)*((S(I)-DEAD(I))/SUMST)
      S(I)=S(I)-B
      REQU(LOD)=REQU(LOD) + B
      IF(IWATER(NOL)-7)67,64,64
67    OTRIB=OTRIB + B
64    CONTINUE
63    CONTINUE
      GO TO 38
C
C     OPTION THREE
C
54    IF(SUMST)38,38,68
68    DO 69 J=1,NS
      IF(DEFMAX(NOL))69,69,77
77    KS=KSERVE(NOL,J)
      DO 70 I=1,NOAMS
      LOD=LODAM(I)
      IF(KS-LOD)70,71,70
71    A=S(I)-DEAD(I)
      IF(A)70,70,72
72    IF(DEFMAX(NOL)-A)73,74,74
74    REQU(LOD)=REQU(LOD) + A
      DEFMAX(NOL)=DEFMAX(NOL)-A
      S(I)=DEAD(I)
      B=A
      GO TO 75
73    REQU(LOD)=REQU(LOD)+DEFMAX(NOL)
```

```
      S(I)=S(I)-DEFMAX(NUL)
      B=DEFMAX(NUL)
      DEFMAX(NUL)=0.0
75    IF(IWATER(NUL)-7)76,70,70
76    OTRIB=OTRIB + B
70    CONTINUE
69    CONTINUE
      GO TO 38
C
C     JUNCTION  POINT
C
35    JUNK(NOLN)=JUNK(NOLN) + 1
      IF(JUNK(NOLN)-1)80,80,81
80    NJNC=NJNC + 1
      QJNC(NOLN)=OTRIB
      NOLD=JUNC(NJNC)
      OTRIB = 0.0
      GO TO 32
81    OTRIB=OTRIB + DACUM(NOLN)
      GO TO 33
36    NOL=NEXT(NOLN)
      GO TO 32
100   CONTINUE
      RETURN
      END
C
      SUBROUTINE RESTOR(NDAMS,STSAVE,S,NFILL2,NFILL,NDRY,NDRY2,NSER,
     1DEFY2,DEFY,NDX2,NDX,NDX4,NDX3,OOLD2,OOLD,NRVBLS,DAMSAV,DAMCON,
     2ABFD2,ABRENT,IS,MPOINT)
      DIMENSION STSAVE(15),S(15),NFILL2(15),NFILL(15),NDRY(15),NDRY2(15)
     1, DEFY2(25,12),DEFY(25,12),NDX2 (25,6,12),NDX(25,6,12),
     2NDX4(25,6),NDX3(25,6),OOLD2(50),OOLD(50),DAMSAV(50,5),DAMCON(50,5)
     3,ABRENT(50,5),ABRFD2(50,5)
C
C
C     RESTORATION OF BEGINNING STATE CONDITIONS FOR CERTAIN PARAMETERS.
C     NECESSARY BECAUSE PROGRAM ATTEMPTS TO ITERATIVELY SATISFY DEMANDS.
C     SEE SUBROUTINE STORER
C
C
C     ARGUMENT DEFINITIONS
C
C     NDAMS= NUMBER OF DAMS IN SYSTEM
C
C     STSAVE-SAVED VALUES OF STORAGE IN RESERVOIRS.
C
C     S-STORAGE IN RESERVOIRS- WORKING VECTOR
C
C     NFILL2- SAVED VALUES OF NFILL
C
```

```
C     [illegible]-COUNTS NUMBER OF TIMES RESERVOIRS SPILLED.- TIME INVARIANT.
C
C     [illegible]- COUNTS NUMBER OF TIMES RESERVOIRS EMPTIES TO DEAD STORAGE.
C
C     [illegible]Z- SAVED VALUES OF NORY
C
C     [illegible]- [illegible] OF TEST AND JUNCTION POINTS IN SYSTEM
C
C     [illegible]Z- SAVED VALUES OF NOEFY
C
C     [illegible]- COUNTER OF SEASONAL DEFICIENCIES TO MET A FLOW TARGET OR
C     WATER QUALITY STANDARD AT ALL TEST SITES.
C
C     [illegible]- SAVED VALUES OF NOX.
C
C     [illegible]
C     [illegible]- COUNTER OF TIMES JTH TARGET WAS VIOLATED DURING THE ITH
C     [illegible] AT THE KTH TEST SITE.
C
C     [illegible]- SAVED VALUES OF [illegible]X3.
C
C     [illegible]-COUNTER OF TIMES WHICH POLLUT. OR FLOW TARGET CAUSED MAXIMUM
C     DEFICIENCY OR FAILURE DURING THE ITH TIME FRAME.
C
C     [illegible]- SAVED VALUES OF OOLD.
C
C     [illegible]- SYSTEM FLOW FROM THE PREVIOUS TIMEFRAME- SEE STORER.
C
C     [illegible]- NUMBER OF POLLUTANTS BEING CONSIDERED.
C     [illegible]SAV- SAVED VALUES OF DAMCON.
C
C     [illegible]- CONCENTRATION OF JTH POLLUT. IN ITH DAM. CONCENTRATIONS AT
C     END OF ITH TIMEFRAME ARE BEGINNING CONCENTRATIONS OF (I+1)TH FRAME
C
C     [illegible]Z- SAVED VALUES OF ARRENT.
C
C     [illegible]- SYSTEM CONCENTRATION OF JTH POLLUT. AT ITH COORD.
C
C     IS- SEASONAL INDEX.
C
C     [illegible]- NUMBER OF COORDINATES IN SYSTEM.
C
      IF(IROW-S)1,1,2
    2 DO 4 I=1,MNABS
      S(I)=SSAVE(I)
      [illegible](I)=NORYZ(I)
    3 [illegible](I)=[illegible]2(I)
    1 DO 6 I=1,[illegible]
      [illegible](I)=[illegible]Z(I)
      IF(NUMPL)14,4,5
```

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```
5     DO 6 J=1,NWVALS
      DAMCON(I,J)=DAMSAV(I,J)
6     AMBENT(I,J)=AMBEN2(I,J)
4     CONTINUE
      DO 7 I=1,NSER
      NDEFY(I,IS)=NDEFY2(I,IS)
      DO 7 J=1,6
      NDX(I,J,IS)=NDX2(I,J,IS)
7     NDX3(I,J)=NDX4(I,J)
      RETURN
      END
C
      SUBROUTINE TAPOTI (NWVALS,NSER,DEFECH,DEFY,DEFX,YRSUM,IS,NSEAS,QQ,
     1AMBENT,S,NDAMS,NPOINT,QOX,LOJUNK,QULMAX,QULMIN,LODAM,DAMCON,DAMMAX
     2,DAMMIN,YRMAX,DEFMAX,YRCON,INVES)
      DIMENSION DEFECH(25,6,12),DEFY(25,6),DEFX(25),YRSUM(25),QQ(50),
     1AMBENT(50,5),S(15),QOX(50,12),LOJUNK(25),QULMAX(25,5),QULMIN(25,5)
     2,LODAM(15),DAMMAX(15,5),DAMMIN(15,5),DAMCON(50,5),YRMAX(25),DEFMAX
     3(25),YRCON(25)
C
C
C     STORING SYSTEM RESPONSE FOR EACH TIME FRAME ON MAGNETIC TAPE.
C     FINDING MAXIMUMS AND MINIMUMS OF CERTAIN PARAMETERS.
C
C     ARGUMENT DEFINITIONS
C
C     NWVALS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
C
C     NSER- NUMBER OF TEST AND JUNCTION POINTS IN SYSTEM
C
C     DEFECH- MAX. FAILURE FOR JTH TARGET DURING ( I SEASON FOR KTH SITE
C
C     DEFY- DEFICIENCIES FOR EACH POLLUTANT AND FLOW TARGET FOR ITH
C     TIME FRAME.
C
C     DEFX- MAXIMAL DEFICIENCY FOR ALL TESY SITES. TIME-INVARIANT.
C
C     YRSUM- ACCUMULATIVE SEASONAL DEFICIENCUES FOR A YEAR AT TEST SITES
C
C     IS- SEASONAL INDEX
      CONTINUE
C
C     NSEAS- NUMBER OF SEASONS ( TIME FRAMES PER YEAR)
C
C     QQ- FINAL SYSTEM FLOWS FOR ALL CO-ORD. FOR EACH TIME FRAME.
C
C     AMBENT- FINAL SYSTEM CONCENTRATIONS OF ALL CO-ORDS. FOR EACH
C     TIME FRAME.
C
C     S- TERMINAL STORAGE IN ALL RESERVOIRS FOR EACH TIMEFRAME.
```

```
C
C     NDAMS- NUMBER OF DAMS IN SYSTEM
C
C     NPOINT- NUMBER OF COORD. IN SYSTEM
C
C     QMX- MAX. SYSTEM FLOW FOR ITH COORD. FOR JTH SEASON.
C
C     LOOKUP- MAP RELATING TESTPOINTS TO COORD. NUMBER. THE (IJUNK)TH
C     IS ITS COORD. NUMBER.
      CONTINUE
C
C     POLMAX- MAXIMUM CONCENTRATION OF ITH POLLUT. AT JTH TEST SITE.
C
C     POLMIN- MINIMUM CONCENTRATION OF JTH POLLUT. AT ITH TEST SITE.
C
C     LOOKAP-MAP RELATING DAM INPUT ORDER TO DAM COORD NUMBER.  THE
C     (IDAM)TH ENTRY IS ITS COORD. NUMBER.
C
C     DAMCON- FINAL CONCENTRATIONS OF POLLUTANTS IN ALL RESERVOIRS FOR
C     EACH TIME FRAME.
C
C     DAMMAX- MAX. CONCENTRATION OF JTH POLLUT  FOR ITH DAM. TIME-INVAR.
C
C     DAMMIN- MIN. CONCENTRATION OF JTH POLLUT  FOR ITH DAM. TIME-INVAR.
C
C     YRMAX- MAXIMUM YEARLY DEFICIENCY FOR EACH TEST SITE.
C
C     DEFMAX- MAXIMUM DEFICIENCY FOR EACH TEST SITE FOR ITH TIME FRAME.
C
C     YRCOU- COUNT OF YEARLY FAILURES AT EACH TEST SITE.
C
C     IOYES- FLAG TO SIGNAL OUTPUT LINK TO FOLLOW.
C
      DO 30 I=1,NSER
      YRSUM(I)=YRSUM(I)+DEFMAX(I)
      IF(IS-NSEAS)30,31,30
31    IF(YRSUM(I))30,30,32
32    YRCOU(I)=YRCOU(I)+1.0
30    CONTINUE
      IF(IOYES-5)34,19,33
33    IF(NOVALS)1,1,2
C
C     FINDING MAXIMUM DEFICIENCY FOR EACH POLLUTANT AND FLOW TARGET
C     FOR EACH SEASON AND FOR ALL TEST SITES.
C
2     DO 3 J=1,NOVALS
      DO 3 I=1,NSER
3     DEFECH(I,J,IS)=AMAX1(DEFECH(I,J,IS),DEFY(I,J))
C
C     FINDING MAXIMAL DEFICIENCY FOR EACH TEST SITE.
```

```
C
1     DO 4 I=1,NSER
      DEFX(I)=AMAX1(DEFX(I),DEFMAX(I))
4     DEFECH(I,6,IS)=AMAX1(DEFECH(I,6,IS),DEFY(I,6))
      IF(IS-NSEAS)5,6,5
6     DO 7 I=1,NSER
C
C     FINDING MAXIMUM YEARLY DEFICIENCY FOR EACH TEST SITE.
C
7     YRMAX(I)=AMAX1(YRMAX(I),YRSUM(I))
5     WRITE (2)IS
C
C     FRAME RESPONSE ON TAPE 2
C
      IF(NNVBLS)8,8,9
9     WRITE (2)((DEFY(I,J),J=1,6),DEFMAX(I),I=1,NSER),(QQ(I),I=1,NPOINT)
     1,((AMBENT(I,J),J=1,NNVBLS),I=1,NPOINT),(S(I),I=1,NDAMS),(YRSUM(I),
     1I=1,NSER),((DAMCON(I,J),J=1,NNVBLS),I=1,NPOINT)
      GO TO 10
8     WRITE (2)((DEFY(I,J),J=1,6),DEFMAX(I),I=1,NSER),(QQ(I),I=1,NPOINT)
     1,(S(I),I=1,NDAMS),(YRSUM(I),I=1,NSER)
C     FINDING MAXIMUM SEASONAL SYSTEM FLOWS FOR ALL CO-ORDS.
C
C
10    DO 11 I=1,NPOINT
      IF (QMX(I,IS)-QQ(I))12,11,11
12    QMX(I,IS)=QQ(I)
11    CONTINUE
      IF(NNVBLS)19,19,20
20    DO 13 K=1,NSER
      KJ=LOJUNK(K)
      IF(QQ(KJ))13,13,14
C
C     FINDING MAXIMUM AND MINIMUM CONCENTRATIONS OF POLLUTANTS AT TEST
C     SITES- TIME INVARIANT.
C
14    DO 15 J=1,NNVBLS
      IF (QULMAX(K,J)-AMBENT(KJ,J))16,16,17
16    QULMAX(K,J)=AMBENT(KJ,J)
17    IF(QULMIN(K,J)-AMBENT(KJ,J))15,15,18
18    QULMIN(K,J)=AMBENT(KJ,J)
15    CONTINUE
13    CONTINUE
      IF(NDAMS)19,19,21
21    DO 22 I=1,NDAMS
      LIM=LODAM(I)
      IF(S(I))22,22,23
C
C     FINDING MAXIMUM AND MINIMUM CONCENTRATIONS OF POLLUTANTS IN
C     RESERVOIRS- TIME INVARIANT.
```

```
C
23    DO 24 NW=1,NWBLS
      IF(DAMFAX(I,NW)-DAMCON(LOD,NW))25,25,26
25    DAMFAX(I,NW)=DAMCON(LOD,NW)
26    IF(DAMSIN(I,NW)-DAMCON(LOD,NW))24,24,27
27    DAMSIN(I,NW)=DAMCON(LOD,NW)
24    CONTINUE
22    CONTINUE
19    CONTINUE
      RETURN
C
      END
      SUBROUTINE WRITOT(IRUN,NYRS,NSEAS,KANT,NWRIT,LOJUNK,NDEFY,NDX3,
     1NSFR,YRC(N))
      DIMENSION NWKIT(12),NDEFY(25,12),NDX3(25,6),PRIN1(12),PRIN2(6)
      DIMENSION LOJUNK(25),YRC(N)(25)
C
C
C     ARGUMENT DEFINITIONS
C
C     IRUN- RUN INDEX
C
C     NYRS- YEARS OF ROUTING
C
C     NSEAS-NUMBER OF SEASONS
C
C     KANT-NUMBER OF TIMES DEFICIENCIES OCCURED AT TEST SITES WHILE THER
C     WAS STILL AVAILABLE STORAGE IN THE PRE-SPECIFIED RESERVOIRS.IMPLIE
C     RESERVOIR ALLOCATION STRADEGY WAS NOT EFFICIENT.
C
C     NWRIT- USED IN HEADING OUTPUT.
C
C     LOJUNK- MAP RELATING TESTPOINTS TO COORD. NUMBER. THE (IJUNK)TH
C     IS ITS COORD. NUMBER.
C
C     NDEFY-COUNTER OF SEASONAL FAILURES TO MEET A FLOW TARGET OR WATER
C     QUALITY STANDARD AT ALL TEST SITES.
C
C     NDX3-COUNTER OF TIMES WHICH POLLUTANT OR FLOW TARGET CAUSED
C     MAXIMUM DEFICIENCY DURING ITH TIMEFRAME.
C
C     NSFR- NUMBER OF TEST AND JUNCTION POINTS.
C
C
C     PRINTS NUMBER AND PROB OF FAILURES
C
      WRITE(6,1)IRUN,NYRS,NSEAS,KANT
      WRITE(6,2)(NWKIT(KA),KA=1,NSEAS)
2     FORMAT (1H 12X,6HSEASON,I2,11I5///)
      DO 3 I=1,NSFR
```

```
    4 FORMAT (1H 14,17,4X,12I5,1H*,I5,5I8)
    3 WRITE (6,4   )I,LOJUNK(I),(NDEFY(I,J),J=1,12),(NDX3(I,J),J=1,6)
    1 FORMAT (1H1 22HOUTPUT SUMMARY FOR RUNI5/1H0 10HROUTING OFI5,2X,5HYEA
     1RS 0FI5,2X,7HSEASONSI7,2X,9HSHORTAGES////1H04HTEST3X,5HCOORD,13X,
     1 31HNUMBER OF SEASONAL DEFICIENCIES,19X,47HNUMBER OF CRITICAL DEFIC
     1IENCIES FOR ALL SEASONS/1H 57X,18X,13HATTRIBUTED TO/1H 75X,
     16HTARG 12X,6HTARG 22X,6HTARG 32X,6HTARG 42X,6HTARG 52X,9HFLOW REQD
     1///)
      FO=NYRS
      FZ=NSEAS*NYRS
      WRITE(6,5)
    5 FORMAT (1H1 4HTEST,2X,2HCO4X,13X,31HPROB.  OF SEASONAL DEFICIENCIES
     1,20X,44HPROB.  OF CRIT. DEFICIENCIES FOR ALL SEASONS/1H 57X,28X,
     113HATTRIBUTED TO/1H 85X,6HTARG 11X,6HTARG 21X,6HTARG 31X,6HTARG 41
     1X,6HTARG 51X,9HFLOW REQD/)
      WRITE(6,6)(NWRIT(KA),KA=1,NSEAS)
    6 FORMAT (1H 9X,6HSEASON,I3,11I6/)
      DO 7 I=1,NSFR
      YRCOU(I)=(YRCOU(I)/FO)*100.0
      DO 8 J=1,12
      FX=NDEFY(I,J)
    8 PRIN1(J)=(FX/FO)*100.0
      DO 9 K=1,6
      FW=NDX3(I,K)
    9 PRIN2(K)=(FW/FZ)*100.0
   10 FORMAT(1H 14,2X,I2,4X,12F6.1,1H*,F6.1,1X,F6.1,1X,F6.1,1X,F6.1,1X,
     1F6.1,/X,F6.1)
    7 WRITE (6,10  )I,LOJUNK(I),(PRIN1(M),M=1,12),(PRIN2(N),N=1,6)
      WRITE(6,11)
   11 FORMAT(1H0 29HPROBABILITY OF YEARLY FAILURE/1H 4HTEST,2X,2HCO/)
      DO 12 I=1,NSFR
   12 WRITE(6,13)I,LOJUNK(I),YRCOU(I)
   13 FORMAT(1H 14,2X,I2,F6.1)
      RETURN
      END
      SUBROUTINE TAPUTZ(NWVBLS,ODX,NPO NT,NSEAS,LOJUNK,QULMAX,QULMIN,
     1COEF,CAP,DEAD,DEFX,NORY,NFILL,LODAM,NDAMS,NDD,NDEFY,YRMAX,NDX,
     1DEFECH,DAMMAX,DAMMIN)
      DIMENSION ODX(50,12),LOJUNK(25),QULMAX(25,5),QULMIN(25,5),CAP(15),
     1DEAD(15),DEFX(25),NORY(15),NFILL(15),LODAM(15),      NDEFY(25,12)
     1,YRMAX(25),NDX(25,6,12),DEFECH(25,6,12),DAMMAX(15,5),DAMMIN(15,5)
     2,MRI(20)
C
C     ARGUMENT DEFINITIONS
C
C     NWVBLS- NUMBER OF POLLUTANTS) (DEGRADABLE,CONSERVATIVE,UNSPECIFED)
C      NPOINT- NUMBER OF COORD. IN SYSTEM
C
C     NOGRAN- NUMBER OF CONSERVATIVE POLLUTANTS
C
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```
C     PKANK- CONCENTRATION OF ITH CONSERVATIVE POLLUT. FOR THE JTH LOCAL
C
C     MXX- MAX. SYSTEM FLOW FOR ITH COORD. FOR JTH SEASON.
C
C     NPOINT- NUMBER OF COORD. IN SYSTEM
C
C     NSEAS- NUMBER OF SEASONS ( TIME FRAMES PER YEAR)
C
C     IJUNK- MAP RELATING TESTPOINTS TO COORD. NUMBER. THE (IJUNK)TH
C     IS ITS COORD. NUMBER.
C
C     QUMAX- MAXIMUM CONCENTRATION OF ITH POLLUT. AT JTH TEST SITE.
C
C     QUMIN- MINIMUM CONCENTRATION OF JTH POLLUT. AT ITH TEST SITE.
C
C     NSER- NUMBER OF TEST AND JUNCTION POINTS IN SYSTEM
C
C     CAP- CAPACITY OF EACH RESERVOIR (UNITS MUST BE INPUT COMPATIBLE
C     WITH STREAMFLOW,BASIF FLOW ,TARGETS,ETC
C
C     DEAD- MINIMUM POOL STORAGE IN EACH RESERVOIR.
C
C     DEFX-MAXIMAL FAILURE FOR ALL SEASONS FOR EACH SITE.
C
C     MEMPTY- COUNTS TIMES RESERVOIRS EMPTY TO DEAD POOL- TIME INVARIANT.
C     CONTINUE
C
C     MFILL- COUNTS NUMBER OF TIMES RESERVOIRS SPILLED- TIME INVARIANT.
C
C     IDAM-MAP RELATING DAM INPUT ORDER TO DAM COORD NUMBER.  THE
C     IDAM ITH ENTRY IS ITS COORD. NUMBER.
C
C     NDAMS- NUMBER OF DAMS IN SYSTEM
C
C     NOPRINT SUPRESS VECTOR-SEE CHAIN 6 + CHAIN 7
C
C     NFLFS- COUNTER OF SEASONAL FAILURES TO MEET  A FLOW TARGET OR
C     WATER QUALITY STANDARD AT ALL TEST POINTS AND JUNCTION POINTS.
C
C     YRMAX-ACCUMULATED SEASONAL FAILURES OVER A YEAR FOR EACH TEST SITE.
C     IN THE DATA PROCESSING LINK(CHAIN6)- ONLY THE LAS  SEASONAL ENTRY
C     OF YRMAX WILL BE USED IN CALCULATING YEARLY STATISTICS.
C
C     MOX-COUNTER OF NUMBER OF TIMES JTH TARGET HAS VIOLATED DURING THE
C     ITH SEASON AT KTH TEST SITE.
C
C     DEFECH- MAX. FAILURE FOR JTH TARGET DURING ITH SEASON FOR KTH SITE
C
C
C     DAMMAX- MAX. CONCENTRATION OF JTH POLLUT  FOR ITH DAM. TIME-INVAR.
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C
C     DAMMIN- MIN. CONCENTRATION OF JTH POLLUT  FOR ITH DAM, TIME-INVAR.
C
C
      IF(NWVBLS)1,1,2
    1 WRITE(3)((DOX(I,J),I=1,NPOINT),J=1,NSEAS),(LOJUNK(I),I=1,NSER)
     1,(NAME(I),I=1,20)
      GO TO 3
    2 WRITE(3)((DOX(I,J),I=1,NPOINT),J=1,NSEAS),(LOJUNK(I),I=1,NSFR),
     1 ((QULMAX(I,J),J=1,NWVBLS),I=1,NSFR),((QULMIN(I,J),J=1,NWVBLS),I=1
     1,NSFR),((DAMMAX(I,J),J=1,NWVBLS),I=1,NDAMS),((DAMMIN(I,J),J=1,NWVB
     1LS),I=1,NDAMS),(NAME(I),I=1,20),(LODAM(I),I=1,NDAMS)
    3 WRITE(10)(LOJUNK(I),I=1,NSFR),(DEFX(I),I=1,NSFR),(CAP(I),DEAD(I),
     1NOWY(I),MFILL(I),LODAM(I),I=1,NDAMS),(NAME(I),I=1,20),((NDEFY(I,J),
     2I=1,NSFR),J=1,NSEAS),(YRDAX(I),I=1,NSFR)
      DO 4 K=1,NSEAS
    4 WRITE (10)((MDX(I,J,K),I=1,NSFR),J=1,6),((DEFECH(I,J,K),I=1,NSER),
     1J=1,6)
      RETURN
      END
```

```
      SUBROUTINE GRAING INVES                                    40010
      DIMENSION I1(5,25,12),I2(5,25,12)                          40020
      DIMENSION I3(5,25,12),I4(5,25,12)                          40030
      DIMENSION I5(5,25,12),I6(5,25,12)
      DIMENSION I7(10,25,12),I8(5,25,12)                         40050
      DIMENSION NOX(25,6,12),SNEFY(25,6,12)                      40060
      DIMENSION YRMAX(25),YRSUM(25)                              40070
      DIMENSION YRMEN(25),YRSD(25)                               40080
      DIMENSION ICOU(25),NWRIT(12)                               40090
      DIMENSION LDJUNK(25),DEFX(25)                              40100
      DIMENSION DEFMAX(25),OO(50)
      DIMENSION SDEY(25),DARCDM(50,5)                            40120
      DIMENSION SSDEY(25),CAP(15)                                40130
      DIMENSION DEAD(15),NFILL(15)                               40140
      DIMENSION NDRY(15),LODAM(15)
      DIMENSION FINI(15),NDO(20)
      DIMENSION S(15), YRHT(25,10)
      DIMENSION S EAN(15,12),FMAXST(25,12)                       40170
      DIMENSION DEFY(25,6),AMBENT(50,5)                          40180
      DIMENSION NDEFY(25,12)
      DIMENSION SSDEFY(25,6,12),FDAM(15,12,10)
      DIMENSION DEFECH(25,6,12),SCRTCH(10)
      DIMENSION SEAMON(25,12),SEASD(25,12),NDE(25),SCRT(10)
C     XXXXX
C
C     DATA PROCESSING LINK 1
C
C     XXXXX                                                      70020
      CALL SLITE(2)                                              70030
      REWIND 2                                                   70050
      REWIND 10
C
C     NRUNS- NUMBER OF PLANS INVESTIGATED
C
      READ(2)NRUNS                                               70070
      IFIN=0
C
C     NSEN-NUMBER OF TEST SITES
C
C
C     NYRS- NUMBER OF YEARS OF ROUTING
C
C
C     NSEAS- NUMBER OF SEASONS PER YEAR
C
C
C     NPOINT- NUMBER OF CO-ORD. IN SYSTEM
C
C
```

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```
C     IRUN- RUN INDEX
C
C     NWVBLS- NUMBER OF POLLUTANTS
C
C
C     NDAMS- NUMBER OF DAMS
C
      READ (12)NSER,NYRS,NSEAS,NPOINT,IRUN,NWVBLS,NDAMS
C
C     INPUT MAPS,MAXIMALS,COUNTS.
C
C
C     LOJUNK- MAP OF T.P. VS CO.-ORD.
C
C     DEFX- MAXIMAL FAILURE FOR EACH TEST SITE.
C
C
C     CAP- RESERVOIR SIZES
C
C
C     DEAD- DEAD POOL STORAGE FOR EACH DAM
C
C
C     NONY- NUMBER OF EMPTIES FOR EACH DAM
C
C
C     NFILL- NUMBER OF SPILLS FOR EACH DAM
C
C
C     LODAM- MAP OF DAMS VS CO.ORD.
C
C
C     NDO- PRINT SUPPRESS
C
C
C     NDEFY- COUNT OF SEASONAL FAILURES
C
C
C     YRMAX- MAXIMUM YEARLY FAILURE FOR EACH TEST SITE
C
C
C     NOX- SEASONAL COUNT OF VARIOUS TYPES OF FAILURES
C
C
C     DEFECH- MAX. SEASONAL FAILURE FOR EACH TYPE OF TARGET
C
C
      READ (10)(LOJUNK(I),I=1,NSER),(DEFX(I),I=1,NSER),(CAP(I),DEAD(I)
     1,NONY(I),NFILL(I),LODAM(I),I=1,NDAMS),(NDO(I),I=1,20),((NDEFY(I,J)
```

```
     1,I=1,NSER),J=1,NSEAS),(YMAX(I),I=1,NSER)
      DO 2 K=1,NSEAS
2     READ (1D)((NDX(I,J,K),I=1,NSER),J=1,6),((DEFECH(I,J,K),I=1,NSER),J   70163
     1=1,6)                                                                 70170
C
C     INITIALIZE
C
      DO 3 I=1,NSER
      YMMEN(I)=0.0                                                          70190
      YMSD(I)=0.0                                                           70200
      ICOU(I)=0                                                             70210
      SDEV(I)=0.0                                                           70220
      SSDEV(I)=0.0                                                          70230
      DO 3 K=1,NSEAS
      NNMIT(K)=K                                                            70260
      DO 3 J=1,6
      SDEFY(I,J,K)=0.0                                                      702?0
3     SSDEFY(I,J,K)=0.0
      DO 4 I=1,NTAMS
      DO 4 J=1,NSEAS
      SMEAN(I,J)=0.0                                                        70310
      DO 4 K=1,10
4     FOAM(I,J,K)=0
      DO 5 J=1,25
      DO 5 K=1,12
      SEAMUN(J,K)=0.0
      SEASD(J,K)=0.0
      FMAXST(J,K)=0.0                                                       70360
      DO 5 I=1,4
      I1(I,J,K)=0                                                           70380
      I2(I,J,K)=0                                                           70390
      I3(I,J,K)=0                                                           70400
      I4(I,J,K)=0                                                           70410
      I5(I,J,K)=0                                                           70420
      I6(I,J,K)=0                                                           70430
      I7(I,J,K)=0
      N=5+I
5     I7(N,J,K)=0
      DO 6 K=1,NSEAS
      DO 6 I=1,NSER
      DO 6 J=1,6
C
C     MAXIMUM SEASONAL FALURE AT EACH TEST SITE
C
6     FMAXST(I,K)=AMAX1(DEFECH(I,.,K),FMAXST(I,K))                          70480
      DO 7 I=1,NSER
      DO 7 J=1,10
7     RMT(I,J)=0.0
C     PROCESSING RESPONSE DATA- HISTOGRAMS, MOMENTS
```

```
C
C
C     LOOPING ON ALL TIME FRAMES- SEE ST.157
C
8     READ (2) IS
      IF(IS-13)9,10,11
C
C     INPUT RESPONSE FOR A FRAME
C
9     IF (NWVBLS)12,12,13
C
C     DEFY- SEASONAL FAILURES FOR EACH TYPE OF TARGET AT EACH TEST SITE
C
C
C     DEFMAX- MAXIMUM FAILURE AT EACH TEST SITE
C
C
C     QQ- SYSTEM FLOWS
C
C
C     AMBENT- SYSTEM CONCENTRATIONS
C
C
C     S- END OF MONTH STORAGE FOR EACH DAM
C
C
C     YRSUM- YEARLY FALURE AT EACH TEST SITE (ONLY LAST SEASON WILL BE
C     USED)
C
C
C     DAMCON- CONCENTRATIONS OF POLLUTANTS IN EACH RESERVOIR
C
C
12    READ (2)((DEFY(I,J), J=1,6),DEFMAX(I),I=1,NSER),(QQ(I),I=1,NPOINT),   70550
     1 (S(I),I=1,NDAMS),(YRSUM(I),I=1,NSER)
      GO TO 14
13    READ (2)((DEFY(I,J),J=1,6),DEFMAX(I),I=1,NSER),(QQ(I),I=1,NPOINT),    70
     1((AMBENT(I,J),J=1,NWVBLS),I=1,NPOINT),(S(I),I=1,NDAMS),(YRSUM(I),
     1I=1,NSER),((DAMCON(I,J),J=1,NWVBLS),I=1,NPOINT)
C
C     FORM HISTOGRAMS OF FAILURES FOR EACH TYPE OF TARGET.
C
14    DO 15 JJ=1,6
      JJ=JJ                                                                 70660
      IF(NDO(JJ))150,150,15
150   DO 16 I=1,NSER
      D=DEFY(I,JJ)                                                          70680
      IF(D)16,16,17
17    L=5.0*D/DEFECH(I,JJ,IS) + 1.0
      L=MINO(5,L)
```

```
      GO TO (18,19,20,21,22,23),JJ
18    I1(L,I,IS)=I1(L,I,IS)+1
      GO TO 16
19    I2(L,I,IS)=I2(L,I,IS)+1
      GO TO 16
20    I3(L,I,IS)=I3(L,I,IS)+1
      GO TO 16
21    I4(L,I,IS)=I4(L,I,IS)+1
      GO TO 16
22    I5(L,I,IS)=I5(L,I,IS)+1
      GO TO 16
23    I6(L,I,IS)=I6(L,I,IS)+1
16    CONTINUE
15    CONTINUE
      IF(NDO(7))151,151,200
C
C     FORM HISTOGRAM OF MAXIMUM SEASONAL FAILURES.
C
151   DO 24 I=1,NSER
      IF (DEFMAX(I))24,24,25
25    L=DEFMAX(I)*10.0/FMAXST(I,IS)+1.0
      L=MIN0(10,L)
      I7(L,I,IS)=I7(L,I,IS)+1                                          70890
      SEAMON(I,IS)=SEAMON(I,IS)+DEFMAX(I)
      SEASD(I,IS)=SEASD(I,IS)+DEFMAX(I)**2
24    CONTINUE
200   DO 27 I=1,NSER
C
C     SEASONAL FAILURE MOMENTS
C
      IF (NWVBLS)28,28,29
29    DO 30 J=1,NWVBLS
      IF(NDO(J+7))152,152,30
152   SDEFY(I,J,IS)=SDEFY(I,J,IS)+DEFY(I,J)
      SSDEFY(I,J,IS)=SSDEFY(I,J,IS)+DEFY(I,J)**2
30    CONTINUE
28    IF(NDO(13))154,154,153
154   SDEFY(I,6,IS)=SDEFY(I,6,IS)+DEFY(I,6)
      SSDEFY(I,6,IS)=SSDEFY(I,6,IS)+DEFY(I,6)**2                       70990
153   IF(NDO(14))155,155,27
C
C     MAXIMAL FAILURE MOMENTS
C
155   SDEY(I)=SDEY(I)+DEFMAX(I)
      SSDEY(I)=SSDEY(I)+DEFMAX(I)**2
27    CONTINUE                                                         71020
C                                                                      71030
C     ANNUAL STATISTICS OF FAILURES                                    71040
C
      IF(NDO(15))156,156,31
```

B 90

```
50     SSA=0.0
44     SDEFY(I,NW,K)=AA
       SSDEFY(I,NW,K)=SSA                                                  71520
41     CONTINUE
160    IF (NW-NWVBLS)45,46,46
45     NW=NW+1
       GO TO 47
46     IF (NW-6)39,49,49
39     NW=6
       GO TO 47
49     CONTINUE
       WRITE (6,52)NYRS,K
       DO 53 I=1,NSER
       IF (NWVBLS)54,54,55
55     NW=1                                                                71650
62     IF(HUD(NW+7)) 165,165,164
C
52     FORMAT (1H1/1H040X,38HSEASONAL DEFICIENCY STATISTICS SUMMARY/1H040  7166
      1X,3HFOR,2X,I4,2X,5HYEARS///1H06HSEASONI5//1H 3X,9HTEST SITE,2X,     71670
      110HCOORDINATE7X,5HWASTE8X,4HDEFS8X,4HMEAN10X,8HSTD DEVN7X,4HPROB,
      110X,22HWASTE 6 IS FLOW TARGET///)
C
165    IF (NDX(I,NW,K))56,56,57
56     PA=0.0
       GO TO 58
57     FN=NDX(I,NW,K)
       PA=FN/FQ                                                            71750
       PA=PA*100.0                                                         71760
58     WRITE (6,59)I,LOJUNK(I),NW,NDX(I,NW,K),SDEFY(I,NW,K),SSDEFY(I,NW,
      1K),PA                                                               71790
59     FORMAT (1H 4I12,E16.4,4X,E12.4,4X,F6.2)
164    IF (NW-NWVBLS)60,61,61
60     NW=NW+1
       GO TO 62
61     IF (NW-6)54,64,64
54     NW=6
65     FORMAT (1H )
       GO TO 62
64     WRITE(6,65)
53     CONTINUE
38     CONTINUE
900    IF(NUD(14))167,167,166
167    WRITE (6,66)
C
66     FORMAT (1H142HSEASONAL COMPOSITE OF MAXIMUM DEFICIENCIES//1H 3X,9H
      1TEST SITE2X,10HCOORDINATE8X,4HDEFS8X,4HMEAN11X,8HSTD DEVN5X,4HPROB  72130
      18X,6HMAXIMA////)                                                    72140
C
       I=1                                                                 71920
67     NO=0
```

```
      DO 68 J=1,NSEAS
   68 NO=NO+NDEFY(I,J)
      NDE(I)=NO
      I=I+1                                                             71980
      IF(I-NSER)69,69,70
   69 GO TO 67
   70 DO 71 I=1,NSER
      NN=NDE(I)
      FN=NDE(I)
      IF(FN-1)72,73,74
   72 PB=0.0
      SDEY(I)=0.0
      SSDEY(I)=0.0
      GO TO 75
   73 SSDEY(I)=0.0
      GO TO 48
   74 SDEY(I)=SDEY(I)/FN
      SSDEY(I)=SQRT((SSDEY(I)-FN*SDEY(I)**2)/(FN-1.0))
   48 PB=100.0*(FN/F2)
   75 WRITE (6,76)I,LOJUNK(I),NN,SDEY(I),SSDEY(I),PB,DEFX(I)
   76 FORMAT (1H 3I12,4X,E12.4,4X,E12.4,4X,F6.2,4X,E12.4)
   71 CONTINUE
  166 IF(NDU(15))'68,168,169
  168 WRITE (6,77)
C
   77 FORMAT (1H1/1H027HYEARLY MAXIMUM DEFICIENCIES/1H 3X,9HTEST SITE2X,
     110HCOORDINATE8X,4HDEFS8X,4HMEAN11X,8HSTD DEVN5X,4HPROB8X,6HMAXIMA/ 72200
     1//)                                                               72210
C
      DO 78 I=1,NSER
      COUNT=ICOU(I)                                                     72230
      IF (COUNT-1.)79,80,800
   79 YRMEN(I)=0.0
      YRSD(I)=0.0
      PR=0.0
      GO TO 78
   80 YRSD(I)=0.0
      PR=100.0*(COUNT/FO)
      GO TO 78
  800 YRMEN(I)=YRMEN(I)/COUNT
      YRSD(I)=SQRT((YRSD(I)-COUNT*YRMEN(I)**2)/(COUNT-1.0))
      SUM=0.0
      DO 8000 IM=1,10
      FI=YRMT(I,IM)/COUNT
      YRMT(I,IM)=SUM + FI
 8000 SUM=SUM+FI
      PR=100.0*(COUNT/FO)
   78 WRITE (6,76 )I,LOJUNK(I),ICOU(I),YRMEN(I),YRSD(I),PR,YRMAX(I)
C
```

```
C     RESERVOIR PERFORMANCE ANALYSIS
C
169   IF (NDAMS)81,81,82
82    IF(NDO(16))170,170,81
170   WRITE(6,83)
83    FORMAT (1H1//1H010X,33HSTATISTICAL SUMMARY FOR DAM SITES////1H010H
     1DAM NUMBER3X,10HCOORDINATE10X,7HEMPTIES3X,6HSPILLS///)             72350
      DO 84 I=1,NDAMS
84    WRITE (6,85 )I,LODAM(I),NDRY(I),NFILL(I)
      DO 840 I=1,10
      F=I
840   SCRTCH(I)=10.0*F
      DO 86 K=1,NSEAS
85    FORMAT (1H I5,8X,I5,15X,I4,I10)
      WRITE(6,87)K,(SCRTCH(I),I=1,10)
C
87    FORMAT(1H139HDISTRIBUTIONS OF STORAGE LEVELS, SEASONI5///1H 4HSITE
     13X,8HCAPACITY,2X,12HDEAD STORAGE7X,4HMEAN5X,83HELEMENTS IN EACH RO
     2W ARE THE PROBS.   ASSOCIATED WITH PERCENTAGES OF CAPACITY SHOWN//
     31H040X,5HEMPTY,10F8.0,4HFULL///)
C
C
C     HISTOGRAMS OF SEASONAL STORAGE FOR EACH RESERVOIR
C
      FD=NYRS
      DO 88 ID=1,NDAMS
      DO 880 I=1,10
880   FDAM(ID,K,I)=FDAM(ID,K,I)/FD
      STAV=0.0
      STAV=SMEAN(ID,K)/FD
89    WRITE (6,91)ID,CAP(ID),DEAD(ID),   STAV,(FDAM(ID,K,L),L=1,10)
91    FORMAT(1H I4,F11.0,2X,F12.0,F11.0,5X,10F8.3)
88    CONTINUE
86    CONTINUE
81    WRITE (6,92)IRUN,NRUNS
      IF(NUX(7))171,171,172
C
92    FORMAT (1H1/1H035HBEGIN DEFICIENCY HISTOGRAMS FOR RUNI4,2X,2HOFI4,
     12X,4HRUNS///)                                                      72630
C
171   DO 93 K=1,NSEAS
      WRITE (6,94)K,NYRS
C
94    FORMAT (1H16HSEASONI5 /1H040X,46HDISTRIBUTIONS OF MAXIMAL SEASONAL
     1 DEFICIENCIES/1H040X,3HFOR,2X,I4,2X,5HYEARS/)
      WRITE(6,970)
970   FORMAT(1H 52HELEMENTS IN FIRST ROW ARE ACCUMULATIVE PROBABILITIES/
     1 1H 57HELEMENTS IN 2ND ROW ARE CORRESPONDING INTERMEDIATE RANGES/)
      WRITE(6,971)
971   FORMAT(1H0/1H02HTP,1X,2HCO,10X,4HMAX.,83X,9X,4HMEAN,9X,4HS.D.//)
```

```
C
      DO 95 I=1,NSER
      IF(FMAXST(I,K))953,953,950
950   IF(NDEFY(I,K)-1)953,951,952
951   SEASD(I,K)=0.0
      GO TO 953
952   FF=NDEFY(I,K)
      SEAMON(I,K)=SEAMON(I,K)/FF
      SEASD(I,K)=(SEASD(I,K)-FF*SEAMON(I,K)**2)/(FF-1)
      IF(SEASD(I,K))954,954,955
954   SEASD(I,K)=0.0
      GO TO 953
955   SEASD(I,K)=SQRT(SEASD(I,K))
953   FJ=NDEFY(I,K)
      SUM=0.0
      DO 956 KM=1,10
      FI=KM
      SCRTCH(KM)=(FI/10.0)*FMAXST(I,K)
      IF(FJ)957,957,958
957   SCRT(KM)=0.0
      GO  TO 956
958   FI=I7(KM,I,K)
      FI=FI/FJ
      SCRT(KM)=SUM+FI
      SUM=SUM+FI
956   CONTINUE
95    WRITE(6,96)I,LOJUNK(I),FMAXST(I,K),(SCRT(J),J=1,10),SEAMON(I,K),
     1SEASD(I,K),(SCRTCH(J),J=1,10)
96    FORMAT(1H I2,1X,I2,E14.4,3X,10F8.3,1H*,E12.4,E13.4/1H 22X,10F8.0/)
93    CONTINUE
172   IF(NDOT(5))173,173,174
173   WRITE (6,97)
C
97    FORMAT(1H1/1H044HDISTRIBUTIONS OF MAXIMUM YEARLY DEFICIENCIES)
      WRITE(6,970)
      WRITE(6,972)
972   FORMAT(1H04HTEST,3X,5HCOORD, 7X,4HMAX.//)
C
      DO 98 I=1,NSER
      SUM=0.0
      DO 980 IK=1,10
      FK=IK
      YRHT(I,IK)=YRHT(I,IK)+SUM
      SUM=SUM+YRHT(I,IK)
      IF(YRMAX(I ))981,981,982
981   SCRTCH(IK)=0.0
      GO TO 980
982   SCRTCH(IK)=YRMAX(I)*(FK/10.0)
980   CONTINUE
98    WRITE(6,960)I,LOJUNK(I),YRMAX(I),( YRHT(I,L),L=1,10),(SCRTCH(L),
```

```
      IL=1,10)
960   FORMAT (1H 14,17,4X,E12.4, 3X,10F9.3/1H 30X,10F9.0/)
174   IF (NWVBLS)100,100,101
101   NW=1                                                            72800
136   DO 102 K=1,NSEAS
      IF(HDO(NW))104,104,103
104   IF (NW-NWVBLS)105,105,106
105   WRITE (6,107)NW
C
107   FORMAT (1H1/1H033X,63HHISTOGRAM OF SEASONAL DEFICIENCIES ATTRIBUTE
     1D TO WASTE VARIABLE(I5)                                         72870
C
      GO TO 108
106   WRITE (6,109)
C
109   FORMAT (1H1/1H011X,98HHISTOGRAM OF SEASONAL DEFICIENCIES ATTRIBUTE
     1D TO A QUALITY FLOW REQUIREMENT OR A WATER SUPPLY NEED)         72910
C
108   WRITE (6,110)NYRS
110   FORMAT (1H040X,3HFOR,2X,I4,2X,5HYEARS///)
      WRITE (6,111)K
111   FORMAT (1H06HSEASONI5/1H04HSITE2X,5HCOORD2X,5HFIFTH,5X,1H18X,1H28X
     1,1H38X,1H48X,1H56X,4HSITE,2X,5HCOORD2X,5HFIFTH5X,1H18X,1H28X,1H38X 72970
     1,1H48X,1H5///)                                                  72980
      GO TO (112,113,114,115,116,117),NW
112   DO 118 I=1,NSER
      DO 118 L=1,5
118   IB(L,I,K)=I1(L,I,K)
      GO TO 119
113   DO 120 I=1,NSER
      DO 120 L=1,5
120   IB(L,I,K)=I2(L,I,K)
      GO TO 119
114   DO 121 I=1,NSER
      DO 121 L=1,5
121   IB(L,I,K)=I3(L,I,K)
      GO TO 119
115   DO 122 I=1,NSER
      DO 122 L=1,5
122   IB(L,I,K)=I4(L,I,K)
      GO TO 119
116   DO 123 I=1,NSER
      DO 123 L=1,5
123   IB(L,I,K)=I5(L,I,K)
      GO TO 119
117   DO 124 I=1,NSER
      DO 124 L=1,5
124   IB(L,I,K)=I6(L,I,K)
119   I=1
125   IF (I+1-NSER)126,126,127
```

```
 126    IP1=I+1
        WRITE (6,128)I,LOJUNK(I),(I8(L,I,K),L=1,5),IP1,LOJUNK(IP1),(I8(L,
       1IP1,K),L=1,5)                                                    73270
 128    FORMAT (1H0I4,I6,8X,I6,4I9,6X,I4,I6,8X,I6,4I9)
        I=I+2                                                            73290
        GO TO 125
 127    IF (I-NSER)129,129,130
 129    WRITE (6,128)I,LOJUNK(I),(I8(L,I,K),L=1,5)
 130    WRITE (6,131)
 131    FORMAT (1H0)
 132    FORMAT (1H031HMAXIMUM DEF. , ORDER IS BY SITE//)
 133    FORMAT (1H 6E20.5)
        WRITE (6,132)
        WRITE (6,133)(DEFECH(I,NW,K),I=1,NSER)
 102    CONTINUE
 103    IF (NW-NWVALS)134,135,135
 134    NW=NW+1
        GO TO 136
 135    IF (NW-6)100,137,137
 100    NW=6
        GO TO 136
 137    CONTINUE
        WRITE (6,138)IRUN,NRUNS
 138    FORMAT (1H1/1H020X,10HEND OF RUNI4,2X,2HOFI4,2X,4HRUNS)
C
C       CYCLE ON RUNS(PLANS)
C
        IF (IFIN-NRUNS)139,140,140
 139    GO TO 1
 140    GO TO 8
 11     REWIND 2
        REWIND 10                                                        73530
        WRITE (6,141)
C
 141    FORMAT (1H1/1H070HFINISHED ALL RUNS. GOING TO CHAIN SEVEN TO PERFO
       1RM QUALITY ANALYSIS   /1H 30HAND FLOW ANALYSIS FOR ALL RUMS)
C
        CALL SPITE(0)                                                    73570
        INVES=7
        RETURN
        END
/*
//FOUR EXEC FORTGCLG,PARM.LKED =LIST,MAP,LET,OVLY:
//FOUR.FORT.SYSLIN DD DISP  MOD,PASS
//FOUR.FORT.SYSIN DD *
        SUBROUTINE CHAIN7 INVES
        DIMENSION GRXMFL(50),GRSDFL(50)
        DIMENSION DEFECH 25,6,12
        DIMENSION YRSUM(25),DEFMAX(25)                                   40010
        DIMENSION S(15),LOJUNX(25)                                       40020
```

```
      SUBROUTINE CHAIN7(INVES)
      DIMENSION GMXMFL%50¤,GMSDFL%50¤
      DIMENSION DEFECH(25,6,12)
      DIMENSION YKSUM%25¤,DEFMAX%25¤                                   40010
      DIMENSION S%15¤,LOJUNK%25¤                                       40020
      DIMENSION UU%50¤,UULMIN%25,5¤,DAMMAX%15,5¤,DAMMIN%15,5¤,DAMCON%50,
     15¤,MUU%20¤,XMDAM%15,5¤,SDDAM%15,5¤, DAMHS%15,5,10¤,XX%15¤
      DIMENSION NWKIT%12¤,SDUU%50,12¤
      DIMENSION FPUU%50,12¤,AMMENT%50,5¤                               40050
      DIMENSION UUX%50,12¤,ZZ%25,12¤,AVAMB%25,12,5¤,SDAMB%25,12,5¤
      DIMENSION  UHIST%25,12,10¤
      DIMENSION DEFY%25,6¤,LODAM%15¤
      DIMENSION UULMAX%25,5¤
      DIMENSION IUU%5,50,12¤,IUFP%5,50,12¤,SCKTCH%10¤,Z1%25¤
C     XXXXX
C
      DATA PROCESSING LINK 2

      XXXXX
      CALL SLITE%3¤                                                    70020
      REWIND 2                                                         70030
      REWIND 3                                                         70040
      READ%2¤NRUNS
      IF(N#0                                                           70060
C
C     INPUT CONTROL DATA
C
C     READ %2¤NSER,NYRS,NSEAS,NPOINT,IRUN,NWVBLS,NDAMS                 70070
      IF %NWVBLS¤2,2,3
    2 READ%3¤%%UUX%I,J¤,I#1,NPOINT¤,J#1,NSEAS¤,%LOJUNK%I¤,I#1,NSER¤ ,
     1%MUUX%I¤,I#1,20¤
      GO TO 4
C
C     INPUT MAPS,MAXIMALS,COUNTS
C
C
C     UUX- MAXIMUM SYSTEM SEASONAL FLOWS AT EACH CO.-ORD.
C
C
C     UULMAX- MAX. CONC. OF EACH POLL. AT EACH TEST SITE
C
C     UULMIN- MIN  CONC. OF EACH POLL. AT EACH TEST SITE
C
C     DAMMAX- MAX. CONC. OF EACH POLL. AT EACH DAM
C
C     DAMMIN- MIN. CONC. OF EACH POLL. AT EACH DAM
C
    3 READ%3¤%%UUX%I,J¤,I#1,NPOINT¤,J#1,NSEAS¤,%LOJUNK%I¤,I#1,NSER¤,
     1%%UULMAX%I,J¤,J#1,NWVBLS¤,I#1,NSER¤,%%UULMIN%I,J¤,J#1,NWVBLS¤,
     1I#1,NSER¤,%%DAMMAX%I,J¤,J#1,NWVBLS¤,I#1,NDAMS¤,%%DAMMIN%I,J¤,J#1,
```

```
      INWVBLSo,I#1,NDAMSo,%NDO0%Io,I#1,2Uo,%LDDAM%Io,I#1,NDAMSo
C
C     INTIALIZE
C
4     DO 5 LL#1,NSER
      DO 5 LK#1,NWVRLS
      DO 5 LM#1,1U
5     UMISTZLL,LK,LMo#U,U
      DO 6 J#1,5U
      GMXMFLXJo#U,U
      GMSUFLXJo#U,U
      DO 6 K#1,12
      FPUUZJ,Ko#U,U                                               70230
      SDUUZJ,Ko#U,U
      DO 6 I#1,5
      IWFPZI,J,Ko#U                                               70270
6     IUUZI,J,Ko#U
      DO 7 K#1,KSER
      ZIXKo#U,U
      DO 7 L#1,NSEAS
      ZZXK,Lo#U,U                                                 70320
      DO 7 I#1,NWVRLS
      AVAMMXK,L,Io#U,U                                            70350
7     SDAMMXK,L,Io#U,U
      DO 8 I#1,NDAMS
      XXXIo#U,U
      DO 8 J#1,NWVRLS
      XMDAMXI,Jo#U,U
      SIDAMXI,Jo#U,U
      DO 8 K#1,1U
8     DAMMSXI,J,Ko#U,U
C
C     BEGIN LOOP FOR INPUTING RESPONSE DATA
C
9     READ X2oIS
      IFXIS-13oIU,11,12
1U    IFXNWVALSoI3,13,14
14    READ X2oXXDEFYXI,Jo,J#1,6o,DEFMAX%Io,I#1,NSERo,%OO%Io,I#1,NPOINTo,
     1 XXAMMENTXI,Jo,J#1,NWVALSo,I#1,NPOINTo,%SS%Io,I#1,NDAMSo,%YRSUM%Io,
     1I#1,NSERo,XXDAMCUMXI,Jo,J#1,NWVALSo,I#1,NPOINTo
      GO TO 15
13    READ X2oXXDEFYXI,Jo,J#1,6o,DEFMAX%Io,I#1,NSERo,%OO%Io,I#1,NPOINTo,
     1 %SS%Io,I#1,NDAMSo,%YRSUM%Io,I#1,NSERo
15    DO 16 I#1,NPOINT
      IFXNUOXI7oo17,17,16
C
C     MOMENTS OF SYSTEM FLOWS
C
17    FPUUXI,ISo#FPUUXI,ISo£UO%Io
      SDUUXI,ISo#SUUUXI,ISo£UO%Io**2
```

```
      GRNFL(I)=GRNFL(I)+Q(I)
      GRSDFL(I)=GRSDFL(I)+Q(I)**2
      IF(Q(I))16,16,18
C
C     HISTOGRAMS OF SYSTEM FLOWS
C
18    L=(Q(I)-5.0)/DQ(I,IS)+1.0
      L=MIN0(25,L)
      IQ(L,I,IS)=IQ(L,I,IS)+1
      IF(L-1)19,19,16
19    L=(0.0-Q(I))/DQ(I,IS)+1.0
      L=MIN0(25,L)                                                70570
      IQF(L,I,IS)=IQF(L,I,IS)+1                                   70580
16    CONTINUE
      IF(NNVBLS)27,27,24
24    IF(NHUR(I)-NN)21,21,210
21    DO 20 K=1,NSEK
      LOJ=KLOJNK(K,L)
      IF (QQ(LOJ)-NN)20,20,23
23    ZZ(K,L,IS)=ZZ(K,L,IS)+1.0
      Z(K,LO)=Z(K,LO)+1.
C
C     HISTOGRAMS OF SYSTEM CONCENTRATIONS
C
      DO 25 NW=1,NWVBLS
      IF(QULMAX(KL,NW)-QULMIN(KL,NW))25,25,26
26    NT=10.0*(CAMBENT(LOJN,NW)-QULMIN(KL,NW))/(QULMAX(KL,NW)-QULMIN(KL,
     1NW))+1.0
      NT=MIN0(10,NT)                                              70790
      CHIST(KL,NW,NT)=CHIST(KL,NW,NT)+1.0
C
C     MOMENTS OF SYSTEM CONCENTRATIONS
C
      AVAMB(KL,IS,NW)=AVAMB(KL,IS,NW)+CAMBENT(LOJN,NW)            70840
      SDAMB(KL,IS,NW)=SDAMB(KL,IS,NW)+CAMBENT(LOJN,NW)**2
25    CONTINUE
20    CONTINUE
214   IF(NDAMS)27,27,28
28    IF(NHUR(I)-NN)29,29,27
C
C     MOMENTS AND HISTOGRAM OF RESERVOIR QUALITIES
C
29    DO 30 I=1,NDAMS
      IF(S(I))30,30,31
31    LOD=LODAM(I)
      XX(I)=XX(I)+1.0
      DO 32 NW=1,NWVBLS
      IF(DAMAX(I,NW))32,32,33
33    XMDAM(I,NW)=XMDAM(I,NW)+DAMCON(LOD,NW)
      SDDAM(I,NW)=SDDAM(I,NW)+DAMCON(LOD,NW)**2
```

B 100

```
      IF(DAMMAX(I,NWO-DAMMIN(I,NW))32,32,1000
1000  NT=10.0*(DAMCON(LOU,NWO-DAMMIN(I,NWO)/(DAMMAX(I,NWO-DAMMIN(I,NWO)
      IF(NT.LT.1)NT=1
      NT=MIN0(10,NT)
      DAMMS(I,NW,NT)=DAMMS(I,NW,NT)+1.0
32    CONTINUE
30    CONTINUE
27    GO TO 9
C
C     END OF  LOOP
C
11    IF(N=IFINC)
      IF(NOUT(17)34,34,35
34    WRITE(6,36)IRUN
C
36    FORMAT (1H1/1H0,27HBEGIN FLOW ANALYSIS FOR RUN,I6///)
      DO 37 K=1,NSEAS
      WRITE (6,38)NYRS,K,NPOINT
C
38    FORMAT(1H1,50X,43HSEASONAL STATISTICS FOR ROUTED SYSTEM FLOWS/1H0
     150X,3HFOR,2X,I4,2X,5HYEARS///1H0,6HSEASON,I5,I7,2X,6HPOINTS///1H
     225(CHNO),5X,13HMAX FLOW PAST,3X,5HFIFTH,4X,1H1,4X,1H2,4X,1H3,4X,
     31H4,4X,1H5,3X,52X,9HMEAN FLOW,1X,9HS.D. FLOW///)
C
      FORMATS                                                           71130
      DO 39 I=1,NPOINT
      IPRINT=0                                                          71140
      DO 40 KK=1,NSEK
      KL=LOUT(KK,KK)                                                    71160
      IF(KL-100)41,41,40
41    IPRINT=1
      GO TO 42
40    CONTINUE
42    AV1=POUT(I,K)/FO
      IF(FO-1.0)43,43,44
43    AV2=0.0
      GO TO 45
44    AV2=(SOUT(I,K)-FO*AV1**2)/(FO-1.0)
      IF(AV2)100,100,101
101   AV2=SQRT(AV2)
      GO TO 45
100   AV2=0.0
45    WRITE(6,46)I,OUT(I,K),(IOUT(L,I,K),L=1,5),AV1,AV2
      IF(IPRINT)39,39,47
47    WRITE (6,48)(IOUT(KL,KL,K),L=1,5)
39    CONTINUE
48    FORMAT (1H 23X,8HFLOW  IF,,5I5/1H )
46    FORMAT (1H I5,E10.4,6X,5I5,51X,2E11.4)
37    CONTINUE
      WRITE(6,49)
```

```
49    FOXMAT %1H1/1H0/1H068HTHE HISTOGRAMS ON THE PREVIOUS PRINTOUT DID
     1NOT INCLUDE ZERO FLUWS. /1H 39HTHE MEANS SHOWN DID INCLUDE ZERO FL   71340
     1OWS ¤
      WRITE%6,50¤
C
50    FORMAT%1H1/1H027HGKAND MEANS AND STD. DEVNS.//1H 5HCOORD//¤
C
      FF#NYKS*NSEAS
      DO 51 I#1,NPOINT
      GKXMFL%I¤#GKXMFL%I¤/FF
      IF%FF-1¤500,500,501
500   GKSDFL%I¤#0.0
      GO TO 51
501   GKSDFL%I¤#SQRT%%GKSDFL%I¤-FF*GKXMFL%I¤**2¤/%FF-1.0¤¤
51    WRITE%6,52¤I,GKXMFL%I¤,GKSDFL%I¤
52    FORMAT%1H I4,2E15.4¤
35    IF%NWVBLS¤53,53,54
54    IF%NWPIX1¤¤55,55,56
55    DO 57 K#1,NSEAS
      K#K                                                                  71420
      NWRIT%K¤#K
      DO 58 KK#1,NSEK
      DO 59 NW#1,NWVBLS
C                                                                          71550
C     MEAN AND S. D. OF QUALITY                                            71560
C                                                                          71570
      IF%ZZ%KK,K¤-1.¤60,60,61
60    SDAMB%KK,K,NW¤#0.0
      GO TO 59
61    AVAMB%KK,K,NW¤#AVAMB%KK,K,NW¤/ ZZ%KK,K¤
      SDAMB%KK,K,NW¤#SQRT%%SDAMB%KK,K,NW¤-ZZ%KK,K¤*AVAMB%KK,K,NW¤**2¤/%Z
     1Z%KK,K¤-1.0¤¤
59    CONTINUE
58    CONTINUE
57    CONTINUE
      WRITE%6,570¤
570   FORMAT%1H1/1H023HSYSTEM QUALITY ANALYSIS//¤
      NW#1
62    WRITE%6,63¤NW,NYKS,%NWRIT%K¤,K#1,NSEAS¤
C
63    FORMAT %1H010X,63HSEASONAL MEANS AND STD DEVNS AT TEST POINTS AND
     1JUNCTION POINTS/1H 10X,18HFOR WASTE VARIABLE,2X,I4/1H 10X,3HFOR,2X   71780
     1,I4,2X,5HYEARS///1H 4HSITE,3X,6HCOORD.///1H 14X,6HSEASON,I2,11I9//   71790
     1¤                                                                    71800
C
      DO 64 II#1,NSEK
      WRITE %6,65¤II,LOJUNK%II¤,%AVAMB%II,KL,NW¤,KL#1,NSEAS¤
64    WRITE %6,66¤%SDAMB%II,KL,NW¤,KL#1,NSEAS¤
65    FORMAT %1H0I4,3X,I6,12F9.3¤
66    FORMAT %1H 13X,12F9.3¤
```

```
      IF%NW-NWVRLS□67,22,22
67    NW#NW&1
      GO TO 62
22    WRITE%6,68□
C
68    FORMAT%1H1/1H052HDISTRIBUTIONS OF SYSTEM CONCENTRATIONS AT TEST SI
     1TES/1H 111HELEMENTS IN FIRST ROW ARE ACCUMULATIVE PROBABILITIES, E
     1LEMENTS IN 2ND ROW ARE CORRESPONDING INTERMEDIATE RANGES/
     2//1H 8HTEST PT.,2X,6HCOOKD,2X,5HWASTE,5X,7HMINIMUM,86X,7HMAXIMUM//
     3/□
C
      DO 69 MM#1,NSER
      LOJN#LOJUNK%MM□
      WRITE%6,70□
70    FORMAT%1H0□
      DO 71 NW#1,NWVRLS
      SUM#0.0
      DO 710 KJ#1,10
      FI#QHIST%MM,NW,KJ□/Z1%MM□
      QHIST%MM,NW,KJ□#FI&SUM
      SUM#SUM&FI
      FK#KJ
      IF%Z1%MM□□711,711,712
711   SCRTCH%KJ□#0.0
      GO TO 710
712   SCRTCH%KJ□#QULMIN%MM,NW□&%QULMAX%MM,NW□-QULMIN%MM,NW□□*%FK/10.□
710   CONTINUE
71    WRITE%6,72□MM,LOJN,NW,QULMIN%MM,NW□,%QHIST%MM,NW,NN□,NN#1,10□,
     1QULMAX%MM,NW□,%SCRTCH%LK□,LK#1,10□
72    FORMAT%1H0I5,I8,I8,6X,F8.2,2X,10F8.3,F11.2/1H 37X,10F8.1□
69    CONTINUE
56    IF%NDAMS□53,53,73
73    IF%NDD%1□□74,74,53
74    DO 75 I#1,NDAMS
      DO 75 NW#1,NWVRLS
      IF%XX%I□-1.0□76,76,77
76    SDDAM%I,NW□#0.0
      GO TO 75
77    XMDAM%I,NW□#XMDAM%I,NW□/XX%I□
      SDDAM%I,NW□#SQRT%%SDDAM%I,NW□-XX%I□*XMDAM%I,NW□**2□/%XX%I□-1.0□□
      SUM#0.0
      DO 750 K#1,10
      FI#DAMHS%I,NW,K□/XX%I□
      DAMHS%I,NW,K□ # FI & SUM
750   SUM#SUM&FI
75    CONTINUE
      WRITE%6,79□
C
79    FORMAT%1H1/1H040HCONCENTRATIONS OF POLLUTANTS AT DAMSITES///1H0
     13HDAM,3X,5HCOOKD,3X,5HWASTE,8X,4HMEAN,8X,14HSTANDARD DEVN.///□
```

72330

```
C
      DO 80 I=1,NDAMS
      WRITE%6,81□
 81   FORMAT%1H0□
      LOD=LODAM%I□
      DO 80 NW=1,NWVBLS
 80   WRITE%6,82□I,LOD,NW,XMDAM%I,NW□,SDDAM%I,NW□
 82   FORMAT%1H I3,I8,I9,2F12.1□
      WRITE%6,83□
C
 83   FORMAT%1H1/1H043HDISTRIBUTIONS OF CONCENTRATIONS AT DAMSITES
     1   /1H 111HEL MENTS IN FIRST ROW ARE ACCUMULATIVE PROBABILITIES, E
     ILEMENTS IN 2ND ROW ARE CORRESPONDING INTERMEDIATE RANGES/
     11H 3HDAM,2X,5HCOORD,2X,5HWASTE,3X,7HMINIMUM,85X,7HMAXIMUM//□
C
      DO 84 I=1,NDAMS
      LOD=LODAM%I□
      WRITE%6,81□
      DO 84 NW=1,NWVBLS
      IF%DAMMIN%I,NW□-99999,□844,845,844
 845  DAMMIN%I,NW□=0.0
 844  DO 840 LL=1,10
      FL=LL
      IF%XXX%I□□841,841,842
 841  SCRTCH%LL□=0.0
      GO TO 840
 842  SCRTCH%LL□=DAMMIN%I,NW□£%DAMMAX%I,NW□-DAMMIN%I,NW□□*%FL/10.0□
 840  CONTINUE
 84   WRITE%6,85□I,LOD,NW,DAMMIN%I,NW□,%DAMHS%I,NW,K□,K=1,10□,DAMMAX%I,N
     1W□,%SCRTCH%K□,K=1,10□
 85   FORMAT%1H I3,2X,I5,2X,I5,F10.2,3X,10F8.3,F9.1/1H 30X,10F8.1□
 53   IF%IFIN-NRUNS□86,87,87
 86   GO TO 1
 87   GO TO 9
 12   REWIND 2                                                          72450
      REWIND 3
      WRITE %6,88□
 88   FORMAT %1H1/1H059HFINISHED ALL RUNS., GOING BACK TO LINK FIVE TO T 72480
     1RY NEW JOB.□
      RETURN
      END
```